EDITORIAL COMMENT

Commodity Prices Driving Metals Industry Capital Investments

Guest Editor
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There was a time, not so very long ago, when steel at $750 per ton and coke at $350 plus per ton was unimaginable. There was also a time, not so very long ago, when most Americans thought everything was being "made in Japan or Taiwan". Welcome to the 21st century, things have really changed and most of us are just coming to understand that the changes, while there will be ups and downs, are here to stay. China and India are evolving rapidly with the third world clamoring to take their places in the development que. In Eastern Europe old economies are rising anew in Poland, Slovakia, and the Czech Republic, challenging Germany and France for regional industrial production.

China is moving the world economy at the margins like no force since the industrial revolution and now accounts for 30 percent of world coal consumption and 40 percent of steel consumption. China has an economy growing at 9 percent in 2004 and even with some cooling expected the affect on commodity prices is predicted to remain strong. The commodity sector is expected to remain strong for at least 5 years out as the 20 year bear market in raw materials has come to an abrupt end.

Global commodity demand is raising, with aluminum up 8 percent, copper up 15 percent, titanium up 22 percent, coke up 200 percent in year over year terms. Coal for power generation has more than doubled in price from last year and projected price changes for 2005 are ranged between an additional 8 to 20 percent. As of late September coal futures on the New York Mercantile exchange were up 56 percent on the year. 70% of Chinese power is produced from coal. Steel scrap prices in the US are also up over 80 percent year on year and the longer term projects no significant lasting correction.

With all this demand driving the market it is predictable that new production capacities will come on line in many sectors. Several projects have been announced. Brazil is looking at a 24 million metric ton steel making facility on its North Coast with the participation of CVRD, Posco, and Baosteel. This complex if fully developed by 2012 will increase Brazil's steel production by 70 percent to 58 million tons per year. BHP Billiton is considering adding 40 million tons of coking coal production by 2010. BHP and Posco are also considering a large iron ore and steel plant in the Indian State of Orissa. Announced investments by the world's three biggest iron ore producers approach $5.3 billion over the next four years. Nelson Silva, commercial director of CVRD recently told the Financial Times: "We believe the steel market will remain in a strong position for at least another three or four years". If these projects are realized the iron ore production of Rio Tinto, CVRD and BHP would rise by 210 million tons by 2008.

The rising costs and continuing demand pressure affecting metals in general creates a pressing need for domestic producers to look at ways of increasing their margins over the longer term. One of the best ways to do this is to look to new technologies and processes which can help increase the bottom line. In exploring this aspect we have selected two papers which discuss the application of new process technologies, helping the metals industries maintain a competitive posture.

- Pet Coke fines production for aluminum anode manufacturing
- Smart Material Screening Machines Using Smart Materials and Controls

As a preamble, however, and with the reprint permission of the Society for Mining, Metallurgy, and Exploration, we want to point out that even the best new technologies are not going to help unless they are effectively implemented as discussed by John O. Marsden of Phelps Dodge in "Technology Development and Competitive Advantage: Sustainable or Short Term?" How many of us have seen organizations or clients analyze a project into oblivion only to be subsequently run over buy competitors who were not so timid.

The current danger, given the lessons learned by the short cyclical duration of past price cycles in the domestic metals market, is that many US companies will wait too long before making investments to permanently reduce costs. Capital project implementation decisions made today typically begin to payback only 18 months out. If current predictions of sustained commodity price pressure are correct US production facilities need to accelerate their investments in cost reduction processes. This action is the only certain protection against shrinking margins and global raw material prices. The climate for high selling prices on finished products to sustain high profits will not last.

The two new process applications highlighted in this issue, for Taconite Ore production and Aluminum Anode production, are representative of the types of day to day cost reduction actions that are constantly adopted by industry. Nothing so radical as to constitute substantial process risk or quantum leaps in overall cost reductions. Like most improvements they are

Biography of Stephan H. Dake, P.E.

Stephan H. Dake, P.E. — Past President of ESWP (1990) and is currently Senior Principal with S/D Engineers Inc. Mr. Dake has been active in the Industrial E&C sector for over 30 years with substantial international experience in the area of technology transfer and project development. During his career he has worked for Blaw-Knox, Dick Corporation, Rust Engineers and Voest Alpine, and is currently acting as advisor for market development to both Putzmeister AG and Claudius Peters GMBH. Mr. Dake has been involved in capital projects for the steel, aluminum, titanium, gypsum, and hydrometallurgy sectors. His most recent focus has been on blast furnace coal injection systems and grinding application for utilizing Pet Coke as supplemental industrial fuel.

Commodity Prices Driving Metals Industry Capital Investments Continued

incremental components in a long cost equation. Both applications adapt technologies across industry boundaries finding ways to save energy, increase efficiency, and improve process consistency. Reliability up and costs down.

The Smart Screen Systems, Inc. application has just been named by R&D Magazine to its Top 100 list for 2004. The high-frequency fine-screening system in use by taconite concentrators on the Minnesota iron range is one of the most technologically significant products introduced over the past year.

The Claudius Peters Anode Coke grinding system is adapted from process applications in regular use by the Gypsum and Coal industries. The technology combines drying, grinding, and adjustable classification into a single process. Costs are reduced both on the capital and operating sides.

In summary the global metals industries are just emerging from a long down market, but as commodity prices have been so low for so long demand has not yet balanced supply. This will happen, and when it does the US facilities need to be ready to produce at lower costs to maintain healthy margins when prices inevitably soften.

Let the capital investment cycle begin!

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Fines Production for Aluminium Anode Manufacturing
With Resultant Cost Reductions

By Dipl.-Ing. Thore Möller,
Claudius Peters Projects GmbH, Buxtehude, Germany

Introduction

For anode production in the Aluminium industry, 20%-30 % of the petroleum coke is used as dust in the "fines" fraction.

This presentation describes the operation of a vertical type mill with an integrated classifier for the anode industry, that was originally introduced in the coal and mineral industry. With this mill, dust can be produced of every fineness and quantity during full time operation, which leads to consistent dust characteristics and minimum storage silo capacity.

The design characteristics of the mill, the control algorithms and the product quality of the production process are the subject of an applied patent.

By use of a vertical ball race mill for production of the fines, may influencing factors can be adjusted during operation and negative influences can be reduced to a minimum.

In addition, this new concept for the anode industry offers further advantages such as:

- Reduced investment costs
- Reduced operating costs
- Reduced metallic impurities in the fines
- Reduced environmental impacts
- Reduced grinding losses
- Increased lifetime of the grinding elements

In the following the principle structure of a vertical ball race mill as well as the process is introduced and the control concept and the advantages of this process are described.

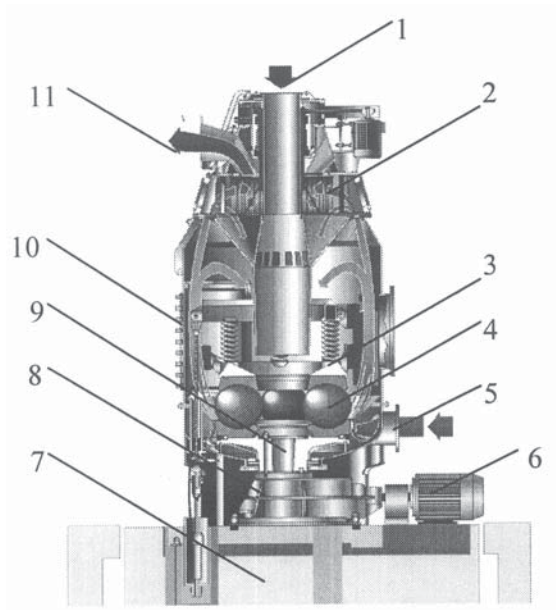

Figure 2. Sectional drawing of a Virtical Ball Race Mill with integrated, dynamic hig-efficiency classifier

Advanced Fines Production for Anode Manufacturing

In other industries the vertical ball race mill, state-of-the-art-technology for several decades now, has been used in particular for the processing of hard and abrasive bulk solids due to its special characteristics. In domains where operational flexibility regarding varying physical characteristics of the grinding material and frequently changing requirements on the ground fines are made, vertical ball race mills are generally used today.

Principal Structure of a Vertical Ball Race Mill

Figure 2 shows the principle structure of a vertical ball race mill with integrated, dynamic high-efficiency classifier.

The vertical ball race mill is a machine where grinding, drying, classifying and conveyance are effected in one single compact unit. The mill operates continuously.

The material to be ground is fed centrally (1) to the mill, falls on the rotating mill yoke (9) and is moved under the grinding balls (4) by means of centrifugal force. It is ground and leaves the grinding area via the exterior circumference of the mill yoke. Here an ambient gas flow (5), which is moving upwards, takes over the material and conveys the ground material to the integrated, dynamic high-efficiency classifier (2). In the classifier the oversized grain is separated and is led back to the grinding area. The ground material of end fineness leaves the mill with the gas stream (11).

The grinding fineness can be readjusted during operation by means of a frequency-controlled motor at the classifier and by adjusting the grinding pressure.

Foreign matter, which reaches the mill (such as stones, steel particles, etc.), is automatically separated during grinding and is collected in a reject gate. The grinding area in the mill is constructed in a way that no dust will accumulate. The grinding pressure in the coke mill is generated by means of a hydraulic pressure device. The hydraulic cylinders which are arranged at the circumference of the mill draw at the tensioning ropes via the piston rods. The tensioning ropes transmit the traction force to the spring tensioning frame. The frame distributes the complete grinding pressure via springs evenly on the pressure ring (3), the upper grinding ring and the grinding balls (4). The grinding pressure is supported by the gear (8) via the mill yoke (9) and is conducted to the foundation (7).

The mill jacket (10) is equipped with two large doors for replacement of the grinding elements as well as a large access opening. The grinding elements can easily be mounted and dismounted by means of a dismantling device .

No sealing air is required due to the simple and solid construction without bearing and lubricating points in the grinding area.

Mill support: The mill support is a welded construction, the lower half of which is embedded in the concrete mill foundation.

A reject gate for falling foreign matter is situated on the side. Foreign matter in the grinding material falls through the nozzle ring and is transferred by the scrapers, which rotate with the grinding yoke, to the reject gate. The foreign matter may be easily removed during operation. A safety device ensures that the reject chamber may only be opened when it is sealed off from the grinding chamber.

If a mill operates under pressure, the passage openings to the grinding chamber must be sealed with an airlock.

The hot air for grinding drying flows through two air inlets into the mill. The zones fed with air are made of heat-resistant material.

Hydraulic cylinders are used in order to produce grinding pressure in the coke mill and these are secured in the foundations. The piston rods are connected by ropes to the spring tensioning frame.

Mill jacket: Mill doors, larger than the diameter, are set in the mill jacket to facilitate installation and removal. The mill jacket is connected above the mill support. Guides with the relevant wear plates are included in the mill jacket to absorb the rotary forces of the spring tensioning frame and pressure ring. The clearance should be readjusted periodically when wear increases.

Integrated, dynamic high-efficiency classifier: The particle/gas mixture flows from the outside to the inside through the guiding blades in the high-efficiency classifier and ends in a tangential flow located between the guiding blade ring and the rotor.

The dividing limit of the classification is determined by the peripheral speed. During operation the fineness can be adjusted without problems by means of a rotor drive with speed-controlling device.

The fine material flows through the rotor bars and leaves the mill together with the gas flow. The oversize particles fall outside the rotor into the course material cone and are transported back to the grinding chamber for further grinding.

An especially adapted sealing, with low wear, located between the rotor and the classifier housing avoids a short-circuit flow and consequently the appearance of oversize particles in the fine material.

Heavy and central lubricated rolling bearings take over the bearing of the rotor. The lubrication is electronically adjusted and controlled. The temperature of each bearing is supervisioned. The calculated design for the roller bearings is made for a continuous operation of more than 10 years.

Gear box: Spiral-toothed bevel spur gears are mainly used. The drive is designed in a way that it may be quickly restarted following an emergency stop of the grinding plant, without the grinding chamber having to be cleared.

The axial forces are taken up by a rocker-segment bearing in the upper part of the housing. By selecting the optimum ratio between segment-bearing diameter and supporting housing walls, only very small bowing stresses occur. The fresh oil enters by way of nozzles between the segments. During operation, oil pressure, oil temperature, flow and differential pressure in the filter are constantly monitored. The amount of gear oil is checked by way of an inspection glass in the housing.

The gears are equipped with an electric oil heater, which is activated when the temperature drops below 15 °C. The mill cannot be started if the oil temperature is lower than 15 °C.

The calculated design for the bearings is made for a continuous operation of more than 60.000 h, the design calculation is based on an AGMA factor of 2,5.

Pressure ring: The pressure ring (Figure 4.) is a cast body for holding the upper grinder ring, with arms located on the circumference, which are supported on the jacket in the direction of rotation. The pressure ring is connected by springs to the spring tensioning frame. The pressure ring guides the upper grinding ring and absorbs the torque at the mill jacket. The pressure ring can move freely vertically in the guides on the mill jacket, in order to compensate for oscillations in the mill bed. This prevents foreign matter blocking and thus damaging the grinding elements.

Mill yoke: The mill yoke (Figure 4.) represents the connection between the lower grinding ring and the segment bearing in the gear. The grinding pressure is supported by the mill yoke in the gear and conducted to the foundation.

Compressing springs: The springs are centered in the guide pipe sockets between the pressure ring and the spring tensioning frame as a flexible connection. The springs have the task to conduct the tension from the spring tensioning frame to the grinding elements as pressure. Additionally, the springs ensure a uniform grinding pressure on the grinding elements.

Spring tensioning frame: The spring tensioning frame (Figure 4.) is a welded construction, running in the mill jacket like the pressure ring. The frame has the same function as the pressure ring. The spring tensioning frame is connected by traction ropes to the hydraulic cylinders in the mill support.

Grinding elements: The grinding elements (Figure 4.) consist of the lower grinder ring, grinding balls and the upper grinder ring.

All the parts are made of die-cast metal, highly resistant to wear. The grinding balls are formed as hollow spheres. The grinding elements are maintenance free. A measurement of the wear needs simply to be carried out at certain intervals, in order to deduce the expected standing time of the grinding parts and to place the operators in the position of being able to plan spare part orders over longer periods.

The lower grinder ring is centered over a recess in the grinding yoke and secured by driver pins. The grinding yoke is attached to the gear output flange. To this extent, the neck of the yoke protrudes from out of the mill support. The grinding is sealed off from the outside by a labyrinth.

Nozzle ring: The nozzle ring is positioned between the lower grinding ring and the mill jacket and seals off the grinding chamber from the hot gas inlet. The nozzle ring is designed as a cast part in the segment construction. The hot air required for drying the ground material enters the grinding chamber via the nozzle ring. In order to prevent ground material falling out, the nozzle ring is set to a minimum airflow speed. Foreign matter in the ground material is able to fall into the reject gate through the nozzle ring.

Hydraulic system: The grinding pressure in the mill is produced by a hydraulic pressure device. The hydraulic cylinders positioned on

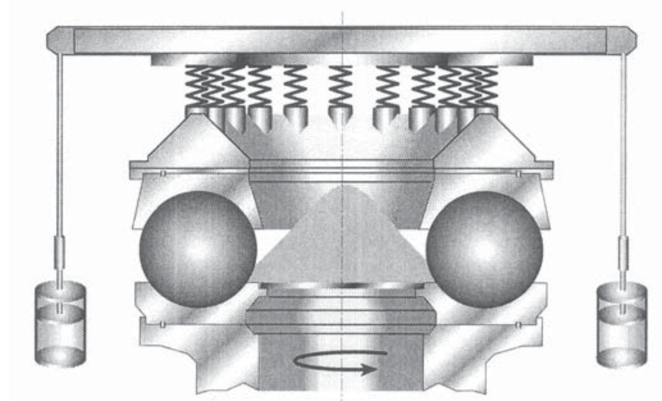

Figure 4. Sectional drawing of grinding zone

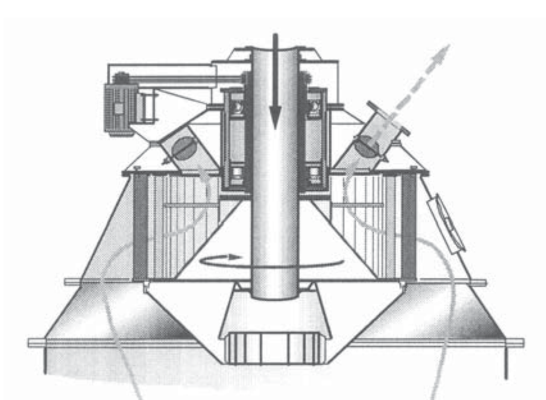

Figure 3. Sectional drawing of dynamic high-efficiency classifier

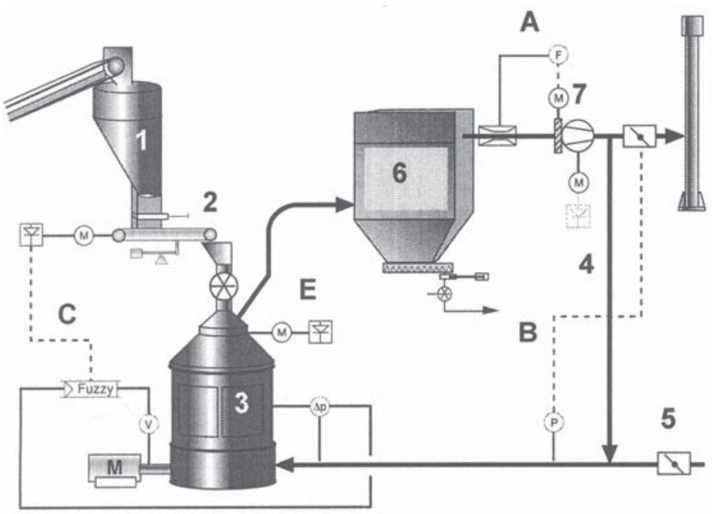

Figure 5. Schematic flowsheet of a grinding plant for calcined petcoke with a vertical ball race mill and integrated high-efficiency classifier

the circumference of the mill pull on the tensioning ropes via their piston rods. The tensioning ropes transmit this tension to the spring tensioning frame. This then evenly distributes the total grinding pressure via springs over pressure ring, upper grinding ring and mill balls. The grinding pressure is then supported by the gears via the grinder yoke and is conducted to the foundation.

While the static pre-tension in the system may be adjusted and is predefined by the hydraulic cylinders, the intermediate compression springs allow smaller strokes during the grinding process.

By altering the hydraulic pressure in the cylinders, the pre-tension in the springs is also defined. With the wear of the grinding elements and balls, the pistons of the hydraulic cylinders automatically follow the worn path. Thus the same, predefined pressure is always maintained and so the total grinding pressure is also kept constant, independent of the state of wear of the grinding elements.

In order to compensate for pressure inconsistencies in the hydraulic system, the mill is equipped with a hydro- pneumatic accumulator. The bubble tank is filled with nitrogen and is placed under a pressure corresponding to about half that of the known grinding pressure.

When the mill is at a standstill, a heater is automatically activated at temperatures below 20 °C, until the predefined temperature is attained.

Dismantling device: A dismantling device is included for replacing the grinding elements. Following its connection, the pressure ring, mill yoke, grinding balls and grinding ring can be easily removed through large doors in the mill support. The grinding elements are removed using hoisting winches suspended from the removal crosspieces.

Advanced Grinding process for fines production

Figure 5 schematically shows the preparation process for production of the fines. The raw calcined petcoke, with a coarseness of 0,1 - 8 mm, is fed through the raw petcoke bin (1) and the belt weigh feeder (2) as flow control facility to the mill. The presented raw material bin design is a round steel plate silo with eccentric outlet. This form has been well-proven in the past and guarantees a trouble-free feeding to the feeder.

The mill (3) is a continuously operating vertical ball race mill where grinding, classifying and conveying can be executed in one closed unit as described in Figure 2.

The petcoke ground to the required fineness is discharged pneumatically from the mill together with a mixture of recirculated gases (4) from the grinding process and fresh air drawn in from the atmosphere (5) and is then separated in the main filter (6).

The largest part of the fines is separated in prechambers off the flow of gas, the dedusting of the rest is effected by filter bags.

The fines are removed from the filter hopper by a troughed screw feeder and a rotary feeder and are fed to the subsequent process phases for production of the green anode mass.

Less than 10 % of the pure gas separated from the fines are pressed through the fan (7) into the stack. This way more than 90 % of the pure gas are returned to the process.

To achieve constant operating conditions during the grinding process, the control algorithms described below are required.

Control Algorithms of grinding process

The grinding plant is equipped with 4 control loops.

Control of air volume (A): The measuring of the air volume is effected between filter and fan by means of a Venturi nozzle. The set value for the air volume is given. The control is effected by means of an air regulator which can be adjusted by motor or a frequency inverter.

Control of pressure level (B): For operation of the mill in clear pressure relations the pressure in front of the mill is being kept constant. The pressure measuring is arranged in the pipeline in front of the mill. The set value for the pressure is given. The control will be effected by a pneumatically-operated adjusting flap in the exhaust gas pipe.

Control of grinding capacity (C): The grinding capacity, which depends on the requirements in the anode factory with regard to fineness and specific surface area and on the Hardgrove Grindability Index of the calcined raw petcoke which varies from 32 – 40 °HGI, can be regulated by means of the feeder speed, and if applicable by adjusting the grinding pressure, process gas flow and mill motor speed.

The belt weigh feeder is continuously adapted to the speed of the necessary grinding capacity. It is possible to operate the feeder in a range between 25 – 100 % of the maximum capacity.

To avoid an over-charge of the mill and to control the vibration set point the delta p measurement in the coke mill will be taken as parameter as well as the vibrations of the gear box. These values are processed in a Fuzzy-Logic module to control the speed of the belt-weigh-feeder.

Control of particle fineness (E): The quality of the fines is defined by the characteristic grain particle diameter d_{50} at a residue / screenings of 50 % in a range of 32 – 55µm and the specific surface according to Blaine between 2000 – 5000cm²/g. These ranges are reached by adjusting the classifier speed via a frequency converter and by adapting the process gas quantity via an adjustable air regulator or a frequency converter.

Product Quality of Fines

The product quality of the fines — defined among other things by the median d_{50} and the range of particle size distribution, the specific surface according to Blaine and the metallic matter from the wear of the grinding elements which come into contact with the product — has a main influence on the production of the green anode mass. This green anode mass is mixed — mostly by adding pitch — from different petcoke fractions, butts, green and baked scrap and is then formed into anodes.

For the production of a homogeneous mixture the constancy of the grain size distribution and the specific surface are decisive. If the fines are too coarse after the grinding process, the specific surface is

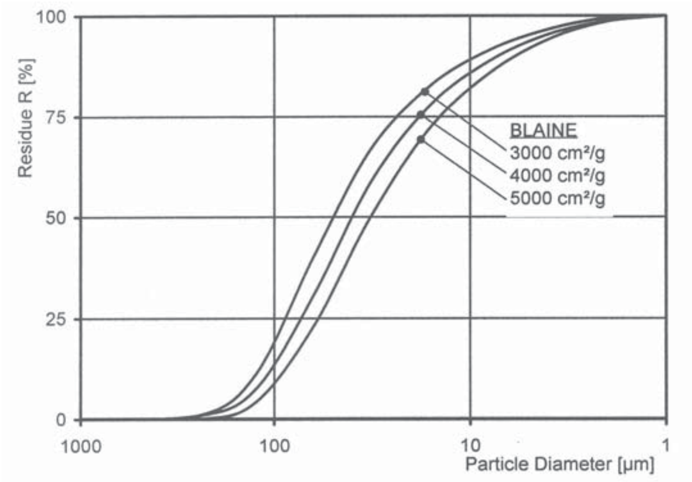

Figure 6. Grain size range of the fines for the production of green anode masses

reduced and the required amount of pitch would become too large. If the fines of the ground product are too small, however, the pitch quantity would not be sufficient to produce a homogeneous green anode mass.

Metallic components determine the quality, i.e. purity of the aluminium, this way having a negative influence on the quality of the light alloy since they enter the molten mass when the electrodes are burnt during the fused mass electrolysis.

Fines grain size distribution

The properties of the fines, characterized by the average grain diameter d_{50} and the grain size distribution, influence the production process of the green anode mass and thus the quality of the anodes.

Figure 6 illustrates the requirements on the characteristics of the fines for production of the green anode mass. The illustration shows the weight-% residue in correlation with the particle diameter.

Conventional processes such as described in Figure 1 must be run in start / stop modus in order to meet the requirements described in Figure 6. With the new system described above, however, the different grain size distributions as shown in Figure 6 are obtained in continuous mode without having to stop the plant.

Figure 7 shows the grain size distributions produced with the new process in continuous industrial operation. The grain size distributions were measured by use of an air-jet screen according to DIN 66 165 part 1/2 [5] down to a mesh width of 32 µm. As one can see, steeper grain size distributions occur which show a lower inclination in the fine range <32µm. The influence of the deviating grain size distributions on the specific surface according to Blaine shall be explained in the following.

Fines specific surface according to BLAINE

The pitch quantities required for the production of the green anode masses are determined depending on the specific surface according to Blaine. The specific surface is reduced / increased by a change of the average grain diameter and the range of grain size distribution. Table 1 shows the required correlation between average grain diameter d_{50} and the specific surface according to Blaine for the production of green anode masses in conventional processes, as described in Figure 1 as well as the average grain diameters d_{50} and screen residue on a sieve with a mesh width of 32µm achieved with the ball race mill process described below.

The measured grain size distributions shown in Figure 7 differ in range as well as in steepness from the required distributions illustrated in Figure 6. As a consequence, the required specific surfaces may be too small or too large. The specific surfaces of the measured grain size distributions shown in Figure 7 were determined in accordance with DIN 66 126, Part 1/2.

The comparatively steeper grain size distribution is compensated for by the fine share with a lower inclination <32µm, so that the required surfaces, as shown in Figure 7, are obtained. A correlation between the specific surface according to Blaine and the average grain diameter d_{50} could not be found. In the grinding process with a ball race mill, the specific surfaces depend on the residue on a sieve with a mesh width of 32µm. Figure 8 shows the measured linear correlation between the specific surface according to Blaine and the residue remaining on a sieve with a mesh width of 32µm.

Based on the findings of Fig-

Specific surface area acc. to BLAINE [cm²/g]	Av. particle diameter in Std. Millsd d_{50} [µm]	Av. particle diameter in Ball Race mills d_{50} [µm]	Residue on 32 µm sieve [W-%]
~3000	~55	~62	~67
~4000	~47	~43	~58
~5000	~32	~35	~50

Table 1. Correlation of the specific surface according to Blaine and the average grain diameter d_{50} in conventional mills and ball race mills

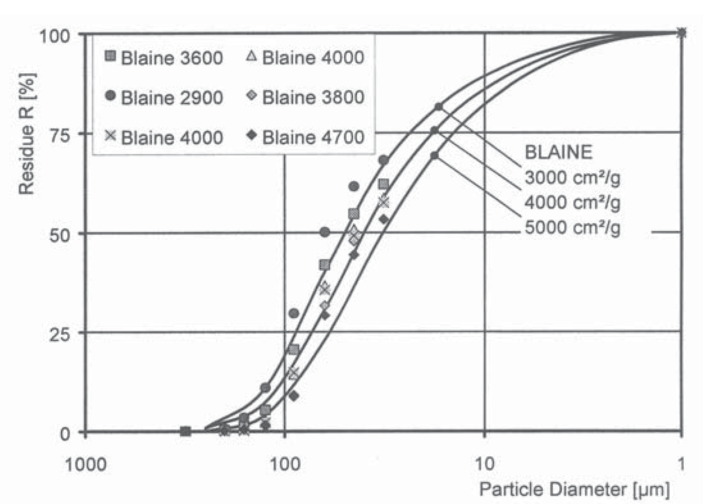

Figure 7. Grain size distributions and surfaces obtained by use of the described process

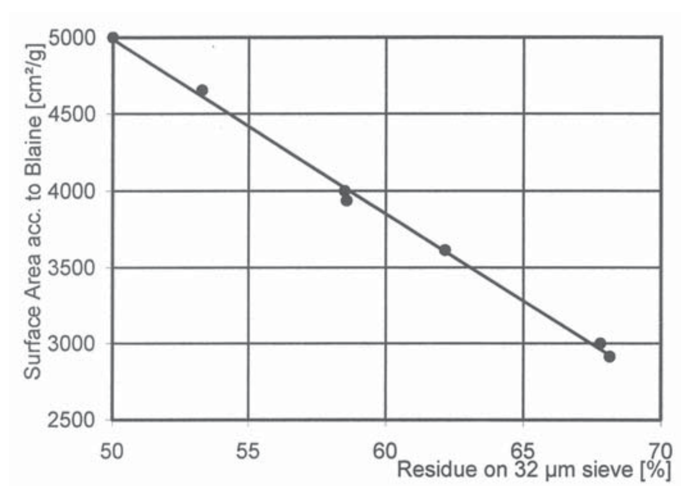

Figure 8. Correlation between the specific surface according to Blaine and the residue on a 32 µm sieve.

Fines Production For Aluminum Anode Manufacturing Continued

ure 8, the quality of the fines can be controlled / monitored by considerably reduced measuring requirements and the process can be adjusted, if necessary, by changing the operating parameters.

Further effects

In addition to reaching the target finenesses and the required specific surfaces of the fines in continuous operation, the new process described above offers further technical and commercial advantages over the conventional grinding process.

Investment costs: Due to the compact design and the lower noise level, compared to conventional mills, the building for the grinding plant is relatively small and the insulation measures to be carried out at the building for noise protection are also far fewer. Further, neither a primary crusher, since the wide range of raw material size is acceptable, nor a filter dust silo with all the corresponding equipment is needed since all dedusting points can be led directly to the main filter.

Operating costs: Maintenance requirements are minimized due to the long service life of the grinding elements. During the guaranteed service life it is not necessary to replace or install grinding balls. The low specific drive capacity of the total plant and the low maintenance requirements make this new process much more economical.

Metallic impurities: The use of highly wear-resistant grinding elements reduces the metallic impurities in the fines and thus in the end product aluminium to a minimum.

Dust emissions: Recirculation of the process gas in the grinding plant cycle limits the exhaust gas quantity to the amount of false air from the individual apparatuses, this way reducing the dust emission into the atmosphere to a minimum.

Grinding losses: Continuous operation, low quantities of calcined petcoke in the mill during the grinding process and the simplest monitoring of the product quality reduce the grinding losses caused by changes in the input material or in the requirements made on the finished product. Further, the silo capacity for the fines is reduced, which leads to a reduction of the segregation in the fines silo and optimizes the quality and the constancy of the fines.

Conclusion

A continuous production of defined dust quantities of any fineness desired from calcined petcoke of different grindabilities by a simple adjustment of operating parameters and a simultaneous minimization of the segregation in the finished product silo is achieved by use of the verticle ball race mill grinding plant concept.

This innovative process is characterized by the use of

- a proven vertical ball race mill
- an integrated dynamic high-efficiency classifier
- an adjusted control concept

This process developed for the aluminium industry is based on long years of experience of CLAUDIUS PETERS in the processing of coal, petcoke, gypsum and other bulk mineral solids. The process is predicted to result in cost reductions which will be significant in the raw material supply context for anode production. A more detailed paper is anticipated in 2005 in conjunction with The Minerals, Metals, and Materials Society (TMS).

Societies NEWS

Pennsylvania Society of Professional Engineers

The Pittsburgh Chapter of PSPE will sponsor a refresher in Spring 2005 for both the Professional Engineer (mechanical, civil, and electrical disciplines) and the Engineering in Training (E.I.T./F.E.) exams. Courses meet one evening per week at the University of Pittsburgh and are scheduled to complement the semiannual examinations administered in the Commonwealth of Pennsylvania. The Spring 2005 Refresher Course is now scheduled for 9 sessions beginning Feb 7, and running through April 11 (no class on March 7), and provide 22 ½ hours of instruction. The deadline for course registration is Jan 28, 2005. A minimum of 10 students is required for each class. Applications for enrollment can be found at www.pittsburghpe.org.

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By Robert H. Scarlett
Smart Screen System, Inc.

The objective of this product is to address the specific need for improvements in the efficiency and effectiveness in physical separation technologies in the high-frequency fine-screening area. Currently, the mining industry uses approximately 33 billion kW-hr per year, costing $1.65 billion at $0.05 per kW-hr, of electrical energy for physical separation of mineral particles. Even though screening and size separations are not the single most energy intensive process in the mining industry, they are often the major bottleneck in the whole process. Improvements to this area offer tremendous potential in both energy savings and production efficiency improvements. Additionally, the conventional vibrating screens used in the mining processing plants are costly, from a maintenance and worker health and safety point of view. The goal of this product is to reduce energy use in the high-frequency screening process and in the processing as a whole. This goal has been accomplished by developing an innovative screening machine that employs smart motors and uses an advanced sensory system to continuously monitor the screening process and make appropriate adjustments to maintain optimum screening performance under varying loads.

The development of Smart Screen technology is based on two key technologies, namely smart actuators and smart Energy Flow Control™ (EFC™), originally developed for military applications. Smart Screen technology controls the flow of vibration energy and confines it to the screen rather than shaking much of the larger mass that makes up the conventional vibratory screening machine. Consequently, Smart Screens eliminate or downsize many of the structural components associated with conventional vibratory screening machines. As a result, the surface area of the screen increases for a given plant area "footprint".

Figure 1: The first Single-Screen Smart Screen

Introduction

Conventional screening machines have one thing in common. They all use an electrical motor with a rotating eccentric shaft that generates the shaking. These rotary electric motor and shaft assemblies are bulky and require maintenance. Furthermore, much of the energy they require is wasted due to useless elastic deformation of the heavy equipment support structure and in the generation of excess noise and excess heat. The excess vibration and heat shortens the useful life of moving components such as bearings — creating excess parts and maintenance cost for a processing plant.

A conventional material screening machine is comprised of four primary and four secondary parts. The primary parts include the key moving components, such as engine, live deck, screen panels, and the screen panel tensioning mechanism. The secondary parts include the non-moving components, such as feed system, supporting structure, hopper, and oversize bins. An electrical engine provides the required shaking by using an eccentric rotating shaft. Typically, an engine rests on the live deck on which a screen panel tensioning mechanism is installed. The screens, that do the material separation, are supported by the tensioning mechanism. The live deck is usually mounted on a main supporting structure at four points using an air- or rubber-based isolation system. The isolation systems are designed to prevent transmission of excess vibrations to the main supporting floor and other parts of a plant. A feed system delivers material at a prescribed flow speed using conveyor belts, gravity feeds and/or pumps. The undersized particles flow into a hopper while the larger particles flow into the oversized bins. The larger particles will be recycled and eventually will be collected as waste.

These types of screening machines have high maintenance cost, downtime, and excessive noise levels. In addition, they have a low productivity rate and a negative impact on workers health and safety. The main issue is that too much heavy metallic parts are shaken for a relatively small payload. Typical engines may weigh about 5 times the screened materials or payload. These engines generate high levels of noise and heat. In addition, they are high maintenance and consume too much energy for generating the required shaking force. An eccentric rotating mass in an engine generates the required oscillatory forces. Since the engine is hard mounted to the live deck, a relatively large steel structure, its vibrations cause the live deck to shake. A typical live deck weighs about 16 times the payload. The shaking of this large steel structure not only generates structural-borne noise but also generates high cycle fatigue and wear. The live deck will in turn vibrate the sieves and their tensioning mechanisms, which weigh about two times the payload. Such a heavy steel structured live deck vibrates other system parts such as the hopper, supporting frame structure, sieve and supporting ribs. In addition, resulting vibrations are usually transmitted to the screen floor, plant offices, and screen attendants. The former issues reduce screening performance and increase maintenance cost, fatigue and negatively affect workers' health.

The total weight of a conventional screening system is about 22 times its payload (the amount of mineral being processed at any given moment). For example, for processing a mineral payload of 50 lbs, the conventional screening system will often weigh a total of about 1100 lbs. The conventional rotary-eccentric-shaft motors are designed to shake a weight that is significantly heavier than the mineral payload. This is the primary reason for the inefficiency of the conventional screening machines. The Smart Screens focus energy on the mineral processing payload and the weight of the vibrating screen elements (the "live" deck) is usually no more than 2 to 3 times the weight of the payload. This makes the Smart Screens more cost-effective and efficient.

Even though screening and size separations are not the single most energy intensive process in a mining or processing plant, they are often the major bottleneck in the overall process. Improvements in this area have demonstrated tremendous potential in both energy savings and production improvements.

A Smart Screen uses an advanced sensory system to continuously monitor the screening process and make appropriate adjustments to maintain screening efficiency. The massive electric rotary-motor-with-eccentric-shaft is replaced with either electromagnetic motors or miniaturized, ceramic-based motors in combination with multi-stage resonators. The "smart" motors are optimized so that the effectiveness and efficiency of the system will be increased by another order of magnitude.

Organization	Facilities/Equipment	Role in This Project
Albany Research Center (ARC)	Characterization laboratory and equipment, wear, erosion and corrosion facility.	Program management, materials specifications, sizing technologies
QRDC, Inc.	Smart materials, vibrations, energy management, screening, modeling, testing, analysis, and evaluation	Program management, smart materials, vibrations, energy management, screening, modeling, testing, analysis, and evaluation
Two Minnesota Mining Companies	Engineering departments, operating processing plants and the associated operations, milling, and maintenance systems. These two mining companies are keys to the project.	Engineering assistance, access to screening operations, staff access, field evaluation, steering committee
Minnesota Technology, Inc.	Business development and technology insertion	Business development and technology insertion
ProtoPhase, Inc.	Machine shop, metal bending, fabrication facility	Prototyping and low volume production
Smart Screen Systems, Inc.	Testing and production facility, engineering staff	Prototype design, function evaluation and validation, product assembly, large volume production, quality control, technical support, worldwide sales and marketing

Table 1 Facilities and Capabilities of the Partners

Motivation and Smart Screen Team

The iron and steel industry is extremely competitive, and recent world economic events have magnified the competition. The "smart" product development program aids the industry by introducing significantly more cost-effective and energy efficient technology to processing and production.

In this continuing product development work, the state-of-the-art smart materials, multi-stage resonators, and the recently patented Energy Flow Control (EFC™) and Vibration Control by Confinement (VCC™ technology are combined to create Smart Screens. This combination of technologies has been investigated and applied in critical systems in the U.S. Department of Defense. The U.S. Army, Navy, and Air Force have contributed to the development of this technology for use in military systems.

To successfully develop and commercialize Smart Screen Systems, a multi disciplinary project a team was put together. Table 1 shows the list of these organizations, their role, and capabilities. The participating mining companies in this project produce 31% (17.65 million tons) of U.S. iron-ore production. Currently, three four iron ore concentrators are using these high-frequency fine-screening systems and are also co-operating in the development of additional refinements and new screening process control schemes.

Smart Screen Approach

Smart Screen concept relies on two key technologies, namely smart materials and smart control. These two key areas plus the overall approach are described in this section.

The current generation of Smart Screens use electromagnetic motors to drive the screening system. Looking to the future, Smart Screen Systems, Inc., has found that piezoelectric ceramic materials (such as PMN=Lead Magnesium Niobate, and PZT=lead zirconate titanate) are particularly well suited for applying dynamic forces, and can deliver the required shaking function to sieves. In addition, these PZT materials will function as collocated sensors and actuators for active control of the shaking action and process automation. Piezoelectric actuators can simultaneously sense vibrations in the structure while applying a force to the structure. This approach relies on a closed loop control system that separates the applied control voltage from the voltage induced in the piezoelectric material by vibration in the structure.

Piezoelectric sensors and actuators for this program may be in the form of patches, monolithic shapes, or multi-layer stacks. Monolithic shapes are fabricated in a wide range of geometries. The equation for the blocking force shows that the highest forces are obtained when the area of the actuator is large and the thickness is small. In fact, the patch actuator is a particular form of the monolithic shape with a high aspect ratio that can provide high forces in the direction of poling and generate relatively large voltages when a force is applied along the length. A multi-layer stack is comprised of a stack of thin layers of material connected electrically in parallel. These stacks multiply the force or extension by the number of layers providing higher forces or strains than a monolithic shape of similar dimensions. The multi-layer stack may be used to reduce the voltage required to obtain the desired level of actuation or shaking.

The collocated sensor/actuator sets may be also be based on PMN stacks that are readily available in the commercial market. The PMN sensor/actuators have been developed for high performance military applications. They can be fabricated in a variety of sizes. For example, 2" diameter and 4.5" long rod-shaped stacks have been successfully fabricated and tested. These stacks have the capability of providing 16000 lbs blocked force and 4.5 mils free displacement. The actual blocking force is determined by the material, size, and voltage. The PMN-based collocated sensor/actuator sets are utilized in conjunction with the state-of-the-art signal processing and control algorithms. Switched Capacitive Amplifies (SCAMP) may be employed for driving capacitive loads. They can be operated with a time delay less than 10 microseconds with voltages in the range of 150 V to 1000 V.

In the future, smart and effective PZT and PMN actuators may be used as the main engine (or motor) to generate the required shaking. A multi-stage resonator may be used to amplify the displacements and accelerations so that the screening function is optimized. For example, stacked cantilever beams may be used as the preliminary design of the multi-stage resonators. Combination of the multi-stage resonators and smart materials offers full control and precision of the shaking function.

In addition to their small size and high blocking force, they can operate at frequencies ranging from DC to Mega Hertz. This feature will offer a precise tuning the screens for the best throughput and effectiveness. On the top of the steady-state vibrations (i.e. shaking), we superimpose a high-energy impulse in order to prevent blinding in sieves.

Driving the motion of the current generation of Smart Screens are two electromagnetic motors (as shown in Figure 1). Typically, because of their design, conventional vibratory screens are limited in their direction, speed and range of motion. These restrictions allow conventional screens to become quickly blocked or "blinded". It is not unusual to have as much as 50% blinding on conventional screens within 24 hours of operation. The energy flow control technology in Smart Screens has the ability to regulate the screen vibration parameters via a standalone PLC. This feature increases the operator's ability to minimize blinding and maintain optimum screening efficiency.

In terms of smart control, Smart Screens rely on the patented Energy Flow Control technology. It is the combination of smart materials and this vibration energy managing method that makes the approach unique and innovative. Energy management may include energy diversion, confinement, dissipation, conversion, and cancellation. The underlying vibration energy management concepts are not new and have been developed for and used in a number of military applications. The basic energy management concept has been practiced in other fields. Examples are heat management in electronic circuits, flow management in thermodynamic systems, money management, and electrical and thermal energy management in buildings and mechanical systems. However, with the exception of the work by Dr. Allaei and Smart Screen Systems, Inc., the vibration energy management concepts have not been previously applied in the context described here.

Energy management is used to deliver focused dynamic (or vibration) energy to the screens through which the physical separation of the material takes place. It has been demonstrated that optimizing energy delivery can increase the process output by a factor of six (6). For example, if a plate is used as a resonator, while input is maintained at the same level, its output can be increased by a factor of six when its elastic energy is focused over 67% of its surface.

The theoretical advantage in the development of the Smart Screen technology is found in the ability to control the flow of energy and in confining this energy to the working screen surface itself — rather than having energy siphoned off to shake the entire screen machine and the surrounding structures. The Smart Screen designs eliminate or downsize many of the structural components typically required for the operation of conventional screens. As a result, it is possible to provide more working screen surface within a given plant space "footprint".

Prototype Description

Reducing the current energy usage, decreasing maintenance cost, and improving throughput in fine screening operations are not trivial tasks. Care has been taken to ensure that economic and engineering data generated in the laboratory, pilot, and plant-scale research and testing are truly scalable to the industry needs. Technical barriers that have been overcome during the development phase are listed below:

- Miniaturization of motors that will generate sufficient force and displacement.
- Anticipating potential material fatigue expected in systems that operate at resonant frequency.
- Effective packaging for survival in a corrosive process environment.
- Development of effective techniques for reducing or eliminating screen blinding and plugging.

Figure 1 shows the first single-screen Smart Screen. It is apparent by the simple design concept that we are utilizing a single panel screen which is driven by two electromagnetic motors. The screen is mounted in the unit so that the deflection of the screen is impeded from transferring to the rigid frame and base – and, ultimately, to the structural steel plant platform. The rigid screen support structure is also isolated from the structural surroundings. The unit is fabricated with stainless steel, to control the effects of corrosion on the useful life of the equipment. The design of the single-screen unit is purposely fabricated so that it can be installed in a typical plant process environment where spills, high humidity and extremes in temperatures can exist.

Figure 3 shows the production Model S3i-102 that recently received the coveted *R&D Magazine* "R&D 100" award — as one of the technologically most significant innovations of 2003.

Results and analysis

Controlling the flow of energy so that the vibration is isolated to the screen itself significantly reduces the power required to accomplish this work. The primary benefits are found in an increase in cost-effective throughput and productivity.

A number of secondary economic benefits are found in energy savings (i.e., shaking only 150 lbs instead of 1100 lbs per machine). For example, a large concentrator might have more than 100 high-frequency fine screens and more than 40 lower-frequency screen in

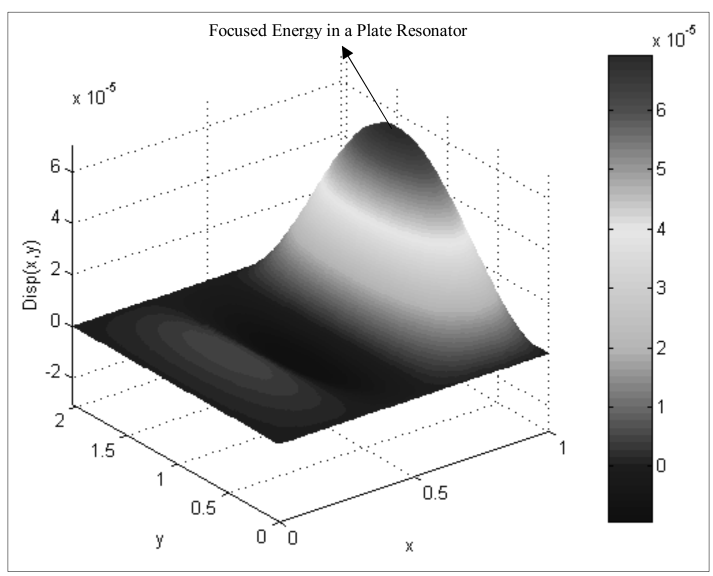

Figure 2: A plate resonator with focuses energy over a limited region

machines. At such a plant, the Smart Screen technology will shake only 20,920 lbs., instead of 118,550 lbs. — an 82% reduction in vibrating weight. Electrical energy makes up a large part of plant operating budget. Excessive screen weight and the inefficient energy management of conventional screens tends to increase operating costs and limit the overall process line efficiency.

The third economic benefit, significant for plants that need to manage Silica content in the pellet fines, is in the Smart Screen's ability to control the desired cut and limit the passing of "middling" particles that can carry Silica into the flotation process. Operation of a more efficient screen improves Silica management and increases process line productivity. Either of these outputs will be greatly beneficial to iron-ore processing.

Specification	Conventional Screening Machines	Smart Screen Systems	Advantages
Noise	90 - 120 dBA	Usually lower than plant background noise	Worker health
Maintenance	High	Very low	Significant reduction in maintenance costs
Weight	1,080 lbs	200 to 230 lbs	79% reduction
Power Consumption	1,975 W	1,481 W	75% reduction

Table 3 Comparison between conventional screening machines and Smart Screen Systems

The Smart Screens have demonstrated their ability to deliver this very substantial economic benefit — particularly in plants employing flotation.

Smart Screen technology requires far less maintenance to keep on line when compared to conventional screens. There are no bearings to lubricate, no wear plates to change, no springs, nuts or bolts to inspect, repair or adjust. Additionally, the Smart Screen panels require no tensioning either when installed or as part of their periodic maintenance. All Smart Screen panels are supplied as self-contained pre-tensioned units. This feature greatly simplifies installation and maintenance which can now be performed quickly, safely and efficiently.

Figure 3: Model S3i-102 Smart Screen

Conventional vibratory screening machines are noisy machines. The design theories and technologies used in Smart Screens virtually eliminate problems associated with excessive vibration or noise. This greatly enhances the workplace environment and helps to maintain health guidelines related to noise.

Other benefits are in the area of environment and health. Smart Screen Systems certainly have a much lower environmental impact due to reduced energy usage and less throw-away parts such as bearing, lubrication, bolts, etc. Anticipated improvements to worker health and safety are important improvements. Smart Screen Systems reduce noise and vibrations and thus, eliminate worker exposure to excess noise and vibrations. Furthermore, safety is improved by reducing noise. The latter offers a better worker environment to communicate and being fully alert at their tasks. It is well know that excess noise can cause distraction and lack of focus among workers**.**

The key functional features of the Smart Screen Systems are compared with conventional screening machines as shown in Table 3. These features are based on the measurements made on the first prototype. Data to be collected during field tests and evaluations will be used to complete this comparison chart.

Summary and Future Directions

We have taken the basic concept of a vibrating screen and deployed Smart Screen technologies to better fit the production, energy conservation and worker health and safety needs of our customers. We identified the need for a design change, applied a proven technology - namely smart actuators and Energy Flow Control™ (EFC™) and Vibration Control by Confinement (VCC™ and assembled a strong team to carry out the tasks. Today we have entered the market and demonstrated some impressive screening results. Wider installation of these Smart Screens will ultimately help processing plants become more productive with less maintenance — while eliminating the excess noise & vibration problems that have come into focus as major worker health concerns.

Development is already progressing on the second generation of Smart Screens which will further enhance the already significant benefits of this new technology. Smart Screen Systems, Inc. is developing "self-teaching" Smart Screens which adapt to the operating conditions in which they are running. Soon, Smart Screen Systems, Inc., expects to combine the two motor technologies (electromagnetic and PZT) to create a hybrid screening machine that will offer significant new operating advantages and support process control schemes previously unavailable to vibrating screen operators.

Technology Development and Competitive Advantage: Sustainable or Short Term?

By John O. Marsden
Phelps Dodge Mining Company, Phoenix, AZ

Technology development has played a crucial role in the minerals industry throughout history. The development of new technology allows mankind to produce metals and minerals at progressively lower cost of production in real terms, and therefore at progressively lower prices, improving their availability, accessibility and utilization worldwide. However, the developers of such technology are not guaranteed to reap the benefits from this effort: There is an expectation that technology developers will gain an advantage over their competitors. Is this a short-term benefit that results from a temporary cost or efficiency improvement, or is it a sustainable longer term "edge" that prevails even after metal or mineral price has been eroded by the implementation of a major step change technology? This issue is examined by reference to several case study examples in the copper industry.

Background

The development and adoption of new technology has played a crucial role in the commodity minerals industry throughout history. As new, cost-efficient technologies are commercialized, the cost of production decreases, and this enables lower grade ore to be processed profitably. This in turn increases the availability and supply of the metal or mineral of interest, and ultimately (in a free market environment where the supply-demand balance determines price) inevitably decreases the metal or mineral price. This leads to the question: Why should mining companies invest in (new) technology development if the result is a decrease in the product price? The answer is to achieve competitive advantage, where the application of new technology enables one or more commodity producers to gain a cost advantage over their competitors, at least for a period of time. The more sustainable and longer term, the greater the competitive edge achieved.

Technology development is costly and, in general, the greater the potential benefit, the higher the cost. The commercial implementation of new technology is inherently risky — the technology has not been applied before and must be proven over time. The risk must be managed, and this involves additional cost and intellectual effort. Finally, both technology development and commercial implementation typically requires significant investment of time. This latter factor is significant where the metal/mineral of interest is a commodity that exhibits cyclical pricing with extended periods of depressed pricing followed by periods of strong pricing. This will be discussed further later.

Sources of Competitive Advantage

There are many sources of competitive advantage that can result from the development and application of new technology. Each of these is listed and briefly reviewed below:

1. Prevent competitors from using the technology

The mining industry is well-accustomed to the use of patenting of technology, processes, equipment, chemicals and reagents, non-commodity supplies, and other aspects of the mining industry. Patents can provide companies with an effective way to protect competitive technology for a significant period, up to twenty (20) years. In addition, the ability to maintain technical know-how, operational expertise and trade secrets as confidential and proprietary information is an alternative (or complimentary) way to protect competitive technology in both the short and long term.

2. Make it hard for competitors to use or duplicate the technology

In some cases, maintaining technical know-how, operational expertise and trade secrets as confidential and proprietary information may be a successful strategy in achieving competitive advantage. The downside with this option is that it is difficult to keep such information as truly confidential and proprietary for a significant period of time. In addition, such a strategy stifles technical and operational interchange between mining operations and companies, and this approach is probably unproductive in the long term.

3. Apply the technology more rapidly than competitors

Being the first to apply a particular technology cost effectively, to rapidly improve the technology, and quickly make a significant impact on a substantial proportion of overall production and costs may provide significant competitive advantage. Alternatively being a "fast follower " or a rapid adapter of technology may provide similar benefits.

4. Apply the technology better than competitors

If you apply a particular technology better than your competitors, either with greater efficiency, at a larger scale, or at lower cost (capital or operating), then competitive advantage may be achieved. A company's ability to do this depends largely on the quality of people and the resources at their disposal to effectively apply technology and innovate within their operations. As a practical matter, it is difficult to achieve sustained competitive advantage by this manner alone because of the mobility of staff (much greater in recent years than historically) and the relatively rapid and free interchange of information throughout the mining industry.

5. Apply the technology to a greater proportion of metal production than competitors

If a technology can be applied broadly across multiple operations or divisions within a company, it is likely to be more advantageous than its application at a single operation by a competitor. For example, a company that can effectively apply a new nickel laterite hydrometallurgical process to 50% of their mineral reserves will derive greater advantage than a similarly sized company that applies the same process to only 5% of their reserves.

6. Derive more value than competitors due to specific geographical, geological or other conditions

One company may have specific geographical or geological factors or other site-specific conditions that renders the application of a particular technology to be more favorable at one or more of their sites than for others. This can be a source of sustained competitive advantage. An example might be a blend of potential acid-producing mineral resources located close to acid-consuming mineral resources that can utilize a technology that produces acid as a by-product.

7. People development and motivation

Technology development activity excites, invigorates and motivates capable and energetic technical and

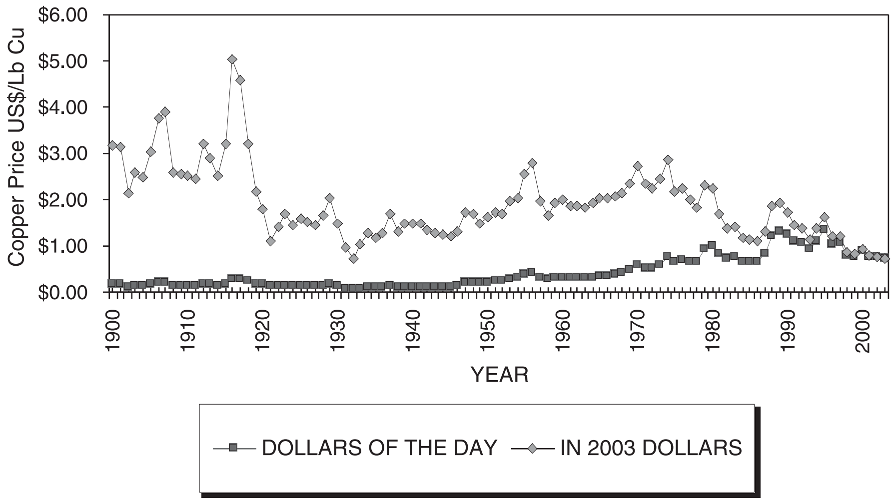

Figure 1 Annual copper price between 1900 and 2003

operating people. Technology development activity gives staff the opportunity to get involved in something new and to create value out of nothing, purely through innovation. This environment gives staff the chance to grow along with the technology being developed. Technology development breeds a contagious enthusiasm — a commodity that can't be easily bought or traded.

Technology Development and Implementation

The "players " in the implementation of new technology fall into four categories, as follows:

"First Mover"

The first mover has the highest risk in applying a new technology, and generally the highest cost. However, there is the potential to apply the technology rapidly and leverage the technology with competitors to gain advantage. The first mover has the potential to reap the largest benefits and, potentially, a sustained competitive advantage.

"Fast Follower " (or Adapter)

The fast follower gains the benefit of the "first mover" experience with the implementation of a new technology. The fast follower or adapter has lower risk compared with the first mover, but risk may still be high because some aspects of the technology may not be fully proven. There may be some potential for the fast follower to leverage the technology and gain significant competitive advantage. In some cases, there may be an ability to gain greater competitive advantage than the first mover as a result of lessons learned.

"Conservative Follower"

The conservative follower takes a low-risk approach, but does whatever needed to stay competitive over the long term, even if the benefits may not be achieved from the technology during its initial period of application. The conservative follower has little opportunity to leverage the technology to achieve competitive advantage and may end up as the one being leveraged.

"Lagger"

The lagger takes the lowest risk option at every opportunity and stays with well-proven technology. They are the last to adopt and apply new technologies, but rely on other ways to stay competitive (e.g., resource quality, captive market or integrated market) or end up exiting the market voluntarily or involuntarily.

Case Study: Technology Development in the Copper Industry

The Copper Price Cycle

Let us consider the example of technology development in the copper industry throughout the 20th century. Figure 1 shows the annual average copper price from 1900 to 2003, with the price expressed in constant 2003 dollars. The period is characterized by peaks and valleys that reflect the market forces for the commodity traded in the western world and, more recently, on a more global basis. During periods where demand has outpaced supply, the peaks occur. Conversely during periods where copper supply exceeds demand, then periods of low price prevail. In general terms, peaks have occurred in 1907, 1912, 1916, 1929, 1937, 1947 – 48, 1956, 1970, 1974, 1979 – 80, 1989, and 1995. Similarly, valley "troughs " have occurred in 1911, 1914, 1921, 1932, 1945, 1958, 1972, 1978, 1986, 1993 and 2002.

During the period 1900 – 2003 shown in Figure 1 (103 years), there have been approximately 9 major price cycles. Table 1 shows the major periods of increasing copper price.

Without exception, these periods of increasing price are related to strong copper demand and consumption, low production (either slow recovery of curtailed production and/or insufficient new production brought onstream to keep pace with demand), or combinations of the two.

Table 2 lists periods of decreasing copper price.

The periods of decreasing price are related to 1) periods of weak copper demand, with excess copper going into exchange invento-

Period	No. of Years
1902 –1907	5
1911 –1916 (Beginning of 1st World War)	5
1921 –1929	8
1932 –1937 (Post-depression)	5
1945 –1956 (Post-2nd World War)	11
1958 –1970	2
1986 –1989	3
1993 –1995	2
Total	41

Table 1 Periods of increasing copper price

Period	No. of Years
1900 –1902	2
1907 –1911	4
1916 –1921	5
1929 –1932	3
1937 –1945	8
1956 –1958	2
1970 –1986	16
1989 –1993	4
1995 –2003	8
Total	52

Table 2 Periods of decreasing copper price

ries or other easily accessible inventories, 2) excessive copper production, either due to slow curtailment of production during a copper cycle downturn or too much new production brought on line in excess of demand requirements during the peak period of the copper price cycle and, as some have postulated, 3) technology developments that increase production and/or lower the cost of production significantly and on a sustained basis.

While there is no doubt that the supply-demand balance drives the copper price, the question of whether significant technology development adversely affects the copper price is more complex. This issue will be examined further using three examples of step change technology development in the copper industry: open pit "bulk " mining, flotation, and solvent extraction-electrowinning (SX/EW).

Large Scale (Bulk) Open Pit Mining

The widespread adoption of bulk, open pit mining methods in the 1920s and 1930s represented a significant technology development for the copper industry. During the period from 1910 to 1945 there were significant increases in ore milling rates, in large part made possible by the bulk open pit mining method. According to A. B. Parsons, Daniel C. Jackling first proposed the use of large-scale, bulk, open pit mining at Utah Copper in 1899. His proposal was based on mining 2,000 tons per day of ore. At the time his proposal was made, the largest copper concentrator was 500 tons per day, so his proposal represented a "stretch " for both mining and processing technology. In 1905, Utah Copper made the decision to proceed with the open pit plan and production started in 1907.(1) It may seem obvious to us now that open pit "bulk" mining makes good economic sense, but at the time this was far from obvious and intuitive. Utah Copper was milling almost 15,000 tons per day by 1910, increasing to 25,000 tpd in 1913 and to about 75,000 tons per day by 1940.(2,4) By contrast, Morenci began large-scale mining in 1942, supplying ore to a 25,000 tons-per-day concentrator, which was increased to over 40,000 tons per day by 1947. El Teniente (originally "Braden") was processing only 6,000 tons per day of ore prior to 1920, but increased to 15,000 tons per day by 1927, and then to about 30,000 tons per day by 1947. Open pit mining started at Inspiration in 1948 and at Ray in 1950. Large-scale open pit mining started at Chuquicamata in about 1927 at a rate of more than 20,000 tons per day and increased to about 50,000 tons per day by 1952.(2) This chronology indicates that many companies were slow to adopt open pit mining methods, even though this ultimately proved to be the most effective mining method.

The above discussion indicates that the major copper producing (porphyry) mines increased ore mining and processing rates dramatically between about 1925 and 1947, with the majority of the major expansions occurring between 1940 and 1947. By 1947, 73% of the US copper production was obtained by open pit mining. (6) Similar developments in Chile followed. As open pit mining took off, the increased scales of economy for the bulk mining and significantly larger processing facilities reduced the cost of production significantly. Then, the mining engineers of the day translated the reduced costs into lower cutoff grades, resulting in a steady decrease in the average grade of ore processed. At many operations, ore grades dropped from over 2% (typical underground mining grades) to 1.5% and in some cases below 1%. Gradually, as ore grades decreased and as wages and other costs inflated over time, production costs shifted back to the prior levels.

A review of the copper price curve (Figure 1) shows that the metal price experienced a sharp decrease from 1916 to 1921, but then a long period of general price increase occurred from the early 1920s to the mid-1970s. This is discussed further at the end of the flotation section.

Re-employment Listings

The re-employment program is a FREE service offered by ESWP on an ongoing basis to all unemployed members and Affiliated Technical Societies members. These individuals are eligible to submit a resume and have a one paragraph summary of their qualifications published in the e-TC, the online TechniCalendar — ESWP's monthly newsletter and calendar, and in the *Pittsburgh ENGINEER*, ESWP's quarterly publication. Potential employers contact ESWP to receive candidates' full resume.

Anyone who meets the above qualifications and would like more information should contact ESWP at 412-261-0710 or eswp@eswp.com.

If your business is interested in any of the following candidates, please contact the ESWP at 412-261-0710 or eswp@eswp.com.

#142 — Seeking a position in construction management in operations, business development or management. Experience: construction management, business development, construction inspection, material sampling/testing. Skills: strong computer skills including proficiency in Word, Excel and other specialty applications; excellent written and verbal communication skills. Degree: BS-Env.Sci, BS-Civil Eng., MS-Civil Eng.

#144 — Seeking a program/project management position to utilize 17 years of experience in a dozen different industries, domestic/international, commercial/government projects, including P/L responsibility, all phases of project life-cycle, risk management, salvaging damaged projects, and optimizing performance of operations, processes and teams. Degrees: MS, PhD, PMP.

#**146** — Seeking position as chemical process engineer. Hard working, tenacious and experienced chemical process engineer; for the past 10 years, the only engineer in a chemical plant with 80 employees, five batch reactors and two Fisher-Provox DCS systems. Experience is broad and includes: process improvement, process trouble-shooting, process control, training, regulatory management, and more. Degrees: MS, BS Chemical Engineering.

#148 — Results-driven manager with expertise in project management, production planning, process improvement, and operations management. Expert at turning around troubled projects. Skilled in translating between business needs and technology requirements. Excellent mentor and manager.

#149 — Customer focused IT Manager with experience in network implementation and support, application, user and desktop support. Skilled at vendor management and purchasing. Experienced in NetWare, Windows and Linux. Implemented variety of systems including Citrix WinFrame, Opentext Document Management and Lotus Notes.

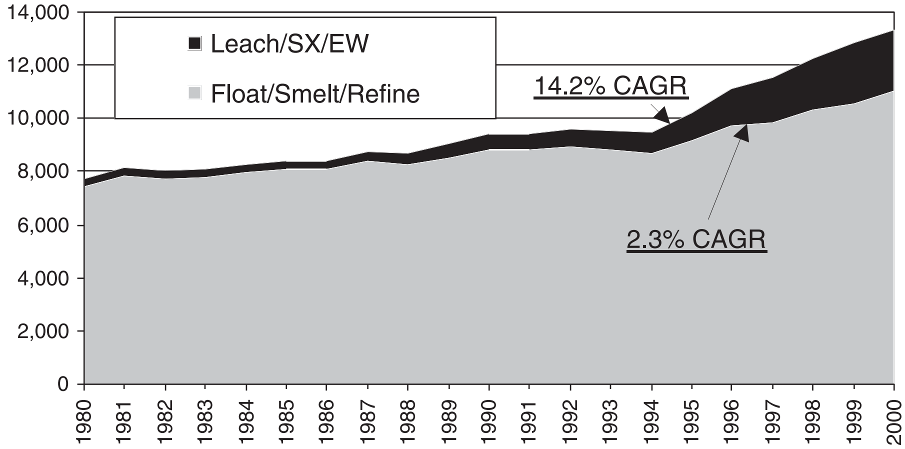

Figure 2 Annual copper production by leaching/SX/EW and flotation/smelting/refining from 1980 to 2000

Flotation

Bulk-oil flotation was patented by Mr. Francis Elmore in 1898 and was first applied commercially on a small scale at the Glasdir mine in Wales in 1899. It was described as a "dirty and nasty process " that cannot have presented much appeal to the owners and operators of the mining and smelting operations of the day. Mr. Elmore further developed this technology into a vacuum-oil flotation process in 1927, and several others developed and patented flotation processes between 1902 and 1907. The Minerals Separation Company was established in 1903 specifically to purchase and exploit the flotation patent that incorporated the use of air, water-soluble oil and dramatically reduced the amount of oil required (below 1%). The early days of flotation, between 1907 and 1923, are marked by extensive legal wrangling and litigation between many of the major copper producers of the day, Minerals Separation Company and others involved with the development and commercialization of flotation technology? This makes for highly entertaining nighttime reading.[3,4]

A number of copper producers tested and used flotation on a small scale. The Central Mill of Broken Hill in Australia is generally recognized as the first commercial application of the flotation process as we know if today, where the process was used to recover zinc. A large number of companies around the world tested the process between 1907 and 1915. In 1907. The Butte and Superior Copper Co. installed a 150-tpd flotation mill for zinc recovery and, because they ignored the Minerals Separation Patent, provoked the first lawsuit. In 1912, Inspiration Copper started testing the response of chalcocite ore to flotation and achieved 87% recovery from 2% copper ore into a concentrate containing 15% copper. The concept was to use flotation in place of traditional gravity concentration. Inspiration built a 50-tpd pilot plant in 1913 and a 600-tpd facility in 1914. Inspiration subsequently agreed to license the flotation process from Minerals Separation Company in 1915, and a 15,000 ton-per-day mill was commissioned in 1915. This plant achieved about 80% copper recovery, with approximately 72% obtained by flotation and 8% by gravity concentration. At the time. This was the second largest concentrator in the world, superceded only by Utah Copper's gravity-based concentrator (25,000 tpd).

Several copper companies tested and licensed the flotation process from Minerals Separation Company, including Anaconda, Miami and Utah Copper. Chino had a 15,000 ton-per-day concentrator that utilized flotation in operation in 1915. In the case of Utah Copper, flotation was first employed at Garfield in about 1918 at a modest scale, and then subsequent expansions and remodeling resulted in the eventual total conversion to flotation by about 1930. During this period, copper recovery increased from 64% prior to 1917, to over 80% by 1919, and then to 90% by 1930.

The importance of these initial large-scale commercial applications cannot be overstated. Firstly, flotation provided a step change in concentrator efficiency and performance by increasing the recovery from typical chalcopyrite and chalcocite ores from typically 64% – 66% by gravity concentration to between 64% - 66% by flotation. Secondly, the widespread commercialization of flotation occurred in parallel with the broad application of open pit bulk mining methods in the copper industry. These two technology developments were intimately linked. Referring to the commercialization of the flotation process, Hines (4) makes the statement "the total effect on the thinking of the mining industry was enormous even if the industry was slow in accepting all the new ideas." In this statement, he was apparently referring to the slow rate of adoption of flotation technology by the industry. But how slow really was this rate? The first large commercial facility was commissioned in 1947. By 1928, there were large flotation mills at Utah, Chino, Miami, Inspiration, Braden, Chuquicamata, and many other copper mines. By 1930, over 50% of US copper production was generated by flotation. It is estimated that over 65% of copper production worldwide (which was dominated by the US and Chile) came from flotation plants at that time.

It is notable that the concentrator operating costs for flotation were about the same as those for the traditional gravity concentration process. However, on average, flotation technology increased copper recovery by about 15%, increasing the divisor by an equivalent amount for the purposes of production cost calculation. This was a huge step change in copper production technology.

Who benefited from the development of flotation? 1) The owners of Mineral Separation Company made a significant amount of money off licensing flotation technology until their patents expired in 1907. The company was liquidated at that time. 2) The first commercial users of the technology and the fast followers gained a significant and sustained production cost benefit. In addition, the reserves of many mines were increased as a result of lowering the cutoff grade of ore processed by up to 20%. This in turn allowed expansions to occur. It is possible that the widespread commercial application of flotation contributed to the dramatic copper price decline experienced in 1930 – 1932. However, undoubtedly this dramatic price decline was heavily influenced by the Great Depression in the US, which greatly reduced copper demand for an extended period. It is interesting to note that this was immediately followed by an extended period of generally increasing price from 1933 – 1973, with some relatively minor dips. It is impossible to determine the exact impact of flotation on copper price. What is clear is that the most progressive, adaptive and innovative copper producers were able to achieve 10 –15 years of competitive advantage from the rapid, broad and large-scale adoption of flotation at their operations. The slow adopters and "laggers " eventually followed or disappeared. By the 1970s, over 90% of primary copper (excluding scrap) was produced by flotation. Flotation has maintained its position as the dominant technology for processing of chalcopyrite and chalcocite ores from 1930 to the present day, although heap leaching is playing an increasing role in the processing of chalcocite ores.

Solvent Extraction and Electrowinning

The third and final example of technology development in the copper industry is the commercialization of solvent extraction (SX)and electrowinning (EW). Liquid ion exchange technology, or "SX " as it is now called, was first used commercially at the Ranchers' Bluebird mine, near Miami, Arizona, in 1968 (5) SX/EW technology replaced the preexisting iron cementation process for the recovery of copper from low-grade copper solution obtained from leaching of oxide ore. Nine million pounds of copper were produced by the new process during its first full year of operation. In 1971, Bagdad installed an SX/EW facility to recover copper from stockpile leach solution. A tailings leach operation was commissioned at the Nchanga division of Zambia Consolidated Copper Mines (ZCCM) in 1974, utilizing SX/EW technology for copper recovery. Additional commercial-scale plants were then installed at Miami-BHP (1976), Miami-Inspiration (1979), Cananea (1980), Pinto Valley (1981), Tyrone (1984), Ray (1985), Gibraltar (1986), Morenci (1987), Sierrita (1987), Chuquicamata (1987), and Chino (1988). Widespread adoption in Chile did not occur until the mid-1990s with applications at Zaldivar, El Abra, Mantos Blancos, Quebrada Blanca and many others.

The major advantages for most of these operations were 1) the replacement of costly and labor-intensive iron cementation process that generated a precipitate for further processing by smelting, and 2) the ability to expand heap and stockpile leaching operations significantly by the use of larger volumes of leach solution as a result of the ability to efficiently process large volumes of low-grade copper solution by SX. This provided a low-cost supplement of copper production to the core flotation concentrator facilities in many cases. The Miami-Inspiration concentrator shut down in 1986 and the Tyrone concentrator shut down in 1992, resulting in both of these operations evolving into an all-SX/EW production base. These events were major milestones that allowed copper companies to consider stand-alone leaching and SX/EW operations to be developed, providing a lower cost process for extracting copper from chalcocite and oxide ores. While many factors affect the production cost calculation and comparison between leaching/SX/EW and flotation/smelting/refining processes for chalcocite ores, it is apparent that the former process route initially presented a 15% – 25% cost advantage. Once again, this was not intuitively obvious at the time and it took a number of years for this concept to germinate into a commercially applicable technology. In the 1990s many stand-alone chalcocite and oxide ore leaching/SX/EW operations were developed and successfully placed into production.

How did the advent of SX/EW technology affect copper market fundamentals? Figure 2 shows the production of copper by leaching/SX/EW and flotation/smelting/refining from 1980 to 2000. SX/EW accounted for about 3% of total primary copper production in 1980, increasing to about 8% by 1927, and to just over 18% by 2000. Similarly to flotation, it is difficult if not impossible to directly link the commercialization of SX/EW technology with a period of copper price decrease. The most likely period of impact is the period 1994 – 2000 when the proportion of copper produced by SX/EW more than doubled. It can be seen that the copper price decreased significantly during the period 1995 – 2001; however, other market forces played a significant role during that period and it is unlikely that technology played a dominant role. The next decade of the copper cycle will reveal more on the impact of SX/EW technology.

Based on remaining copper reserves by ore type, it is projected that leaching/SX/EW will account for about 21% of total production by 2010. This assumes that there is no technology breakthrough for the atmospheric leaching of low-grade chalcopyrite ores and excludes any impact of leaching processes to treat concentrates as an alternative to smelting and refining.

Other Technology Developments

There have been many other technology developments that are not discussed here. Some of the other significant developments include the reverberatory furnace, tube and ball milling, flash smelting, autogenous and semi-autogenous milling, in-pit crushing and conveying, computer control of processing and mining operations, and use of increasingly large-scale mining equipment. (7) There have been many other incremental improvements, changes and innovations that have helped shape the copper industry over time. Many of these have provided sustainable competitive advantage to the users of the technology.

Impact of Technology Developments on Production Costs

Figure 3 shows the full production cost curve for primary copper production (excluding scrap) for 1992, 1996 and 2000. The full cost includes cash production cost plus depreciation and amortization. The graph shows that as production volume increased over time from 1992 to 2000, the cost curve flattened and the average production cost decreased from \$0.74/lb to \$0.61/lb. A significant portion of this decrease was due to low cost, new production coming on line, but a portion was due to technology developments. However, an important point to make from this graph is that relatively modest decreases in production cost can have a huge impact on competitiveness between mines and companies. For example, a 15% decrease in production cost, say from

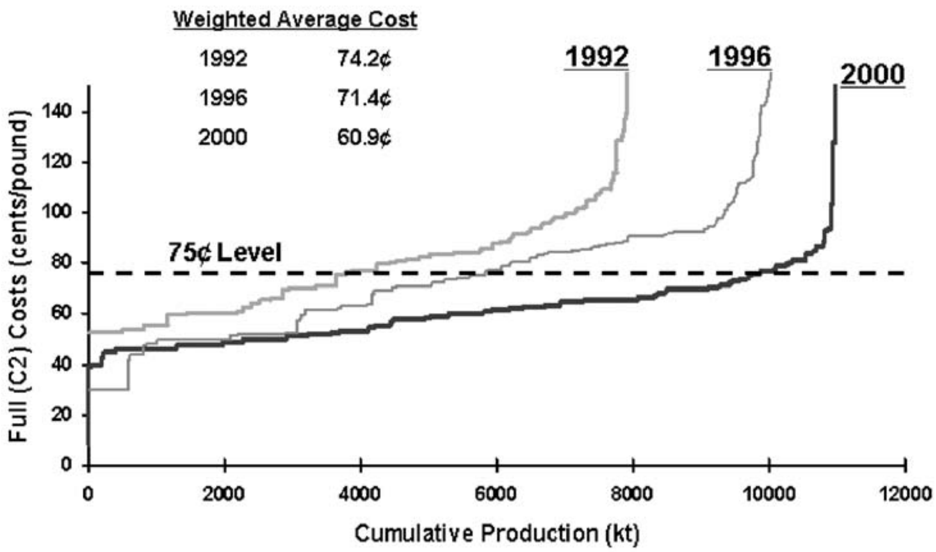

Figure 3 Estimated copper production cost curves for 1992, 1996 and 2000

$0.70/lb to $0.60/lb, moves a producer from the bottom of the fourth quartile to the top of the second quartile on the cost curve. The producers who adopted open pit mining, flotation and SX/EW technology reaped the benefit of similar order-of-magnitude changes in their cost profile and changed the fate of their companies forever. Sustainable competitive advantage indeed.

Summary and Conclusions

Competitive technology developments have reduced the production costs for all commodity metals over time, either through significant step changes, such as those discussed in detail above, or by incremental change. In the case of copper, there is some evidence that major step change technology developments have contributed to an increased availability of commodity metals, resulting in downward pressure on metal prices. However, other market forces including reserve and resource availability and quality, mine investment decisions, commodity metal demand, economic conditions and trends, and other factors have dominating effects on the long-term commodity metal markets.

In the case of the three examples used in the copper industry case study, much of the industry was slow to adopt new technology, even after its effective use had been clearly (and publicly) demonstrated. Step change technology developments allow the innovative and progressive producers to achieve a sustained advantage over a significant proportion of their competitors for periods of 10 –15 years, and in some cases even longer.

While the use of patenting and the confidential retention of proprietary know-how, trade secrets and expertise can be effective in providing short-to medium-term competitive advantage, it is probably other factors such as the speed of adoption, the effectiveness of implementation, and the scale of application of new technology that provides the biggest competitive advantage. The ability to apply technology more widely throughout an organization than a competitor is an advantage that in many cases cannot be duplicated due to geographical and geologic (resource) factors.

In conclusion, this author believes that a strategically-driven and sharply focused technology development effort, along with an effective implementation program that actively manages risk, is a requirement for every thriving, sustainable mining company.

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Event NEWS

121st ESWP Annual Banquet Wednesday, February 23, 2005

Featured Guest Speaker:
John Surma
President & CEO
US Steel Corporation

We are pleased to announce Mr. John Surma as the Guest Speaker for the 2005 ESWP Annual Banquet. Mr. Surma is President and CEO of US Steel Corporation.

The 121st Annual Banquet will help mark ESWP's 125 year history. The Banquet will be held on **Wednesday February 23, 2005** at the Sheraton Station Square Hotel. Sponsorship opportunities and Banquet Reservations will be available November 1, 2004.

John P. Surma Jr. was born in Pittsburgh, Pa., in 1954. He graduated from Pennsylvania State University in 1976 with a bachelor of science degree in accounting.

Mr. Surma joined Price Waterhouse LLP in 1976 and was promoted to manager in 1981. He served in the Manchester, England, office of the Price Waterhouse United Kingdom firm during that same year. In 1985, he was promoted to senior manager, and in 1987 was admitted to the partnership.

In 1983, Mr. Surma participated in the President's Executive Exchange Program in Washington, D.C., where he served as executive staff assistant to the vice chairman of the Federal Reserve Board.

In 1997, Mr. Surma joined Marathon Oil Company as senior vice president, finance & accounting. He was appointed president, Speedway SuperAmerica LLC in 1998, and senior vice president, supply & transportation for Marathon Ashland Petroleum LLC (MAP) in 2000. He was named president of MAP on January 1, 2001.

Effective with the separation from USX Corporation, he became vice chairman and chief financial officer of United States Steel Corporation on January 1, 2002. He was named president in March 2003, and president and chief operating officer in June 2003. He was elected to his current position, president and chief executive officer, in October 2004.

Mr. Surma is a member of the board of directors of Mellon Financial Corporation and Calgon Carbon Corporation. He is also a member of the board of directors of the National Association of Manufacturers, the American Iron and Steel Institute, and the International Iron and Steel Institute. He serves as a member of the University of Pittsburgh Katz Graduate School of Business Board of Visitors and Pennsylvania State University's Smeal College of Business Board of Visitors. He is also a member of the American Institute of Certified Public Accountants

ESWP Annual Awards: Call for Nominations

Application Submittal Deadline is January 9, 2005

The ESWP Engineers' Week Committee is pleased to announce the Call for Nominations for the 2004 Engineer and Project of the year Awards.

Each year, it is our goal to recognize an exemplary engineer and an outstanding project from the Western Pennsylvania region. Awards will be presented in a ceremony during the ESWP Annual Banquet. The attention that these awards will bring will highlight the important contributions engineers make to our society. It is the hope that these awards will represent a meaningful impetus in attracting the best minds to the field and encouraging those in the field to excel at their work.

Nominations for ESWP Engineer of the Year and ESWP Project of the Year can be submitted by any member of the ESWP, its affiliated technical societies or member companies. The Committee will seek candidates that exhibit evidence of leadership, innovation, and service to the engineering profession and society.

If you would like to make a nomination for either of these awards please visit www.eswp.com/eswp/annual_awards.htm to obtain a copy of the awards nomination form.

Should you have any questions or comments, plese contact David Teorsky, ESWP General Manager, at d.teorsky@eswp.com or by telephone at 412-261-0710 ext. 15.

Mark Your Calendar…

The Engineers' Society of Western Pennsylvania Annual Holiday Luncheon December 17, 2004 11:30AM – 2:00PM

There is Still Time to Book Your Holiday Event at the ESWP!

ESWP has numerous options to accommodate your group — office staff, client entertaining or company party. We offer arrangements for breadfast, lunch or dinner, and of course, we are available on the weekends too! No matter if your group is small or large, we can help.

Michael Gaetano, ESWP Banquet Manager, is available to make your holiday event a success. If you would like more information about holding your holiday event the Engineers' Society, please contact him at m.gaetano@eswp.com or call 412-261-0710 ext. 16 for more information.

Visit www.eswp.com/eswp/banquet_facilities.htm for banquet information.

EDITORIAL COMMENT

Transportation Overview

Guest Editor

J. Fred Graham, Jr., PE and grandson, Patrick Graham-Lovenguth

As we all know, Pittsburgh was borne of transportation. Our rivers played the major part. Transportation was the key to the industrial growth of Pittsburgh and the area. We were fortunate enough to have these waterways and rails to feed the industrial sites.

During WW 2, the Pittsburgh area provided twice as much steel as both Germany and Japan combined. The Pittsburgh area has always supported the nation whether it was providing, goods, materials or volunteers. Our region has sacrificed with their lives, their health and now their jobs. Our biggest export today is our educated children because enough good positions are not in Pittsburgh.

So why has the Federal Government neglected Pittsburgh for so long? Or have they? We have more to offer than many regions. Let us look at our rivers and its transportation system. As other cities are growing, we are declining but as the other cities water supply is decreasing, ours is constant. Our rivers are used for transportation, recreation, water supply and manufacturing. However, most of our waterway facilities are not modern.

Although recently, the Corps of Engineers placed a new dam at Braddock on the Monongahela River, the rest of the lock system is antiquated. If you travel on the Ohio River below Pennsylvania, you will pass through locks that can accommodate tugs and a complete set of barges at one time. However when the same tug and barges travel on the Ohio, Allegheny or Monongahela Rivers, the barges must be split causing time loss and a financial cost as well. The Corps of engineers, over the years has been downsized and now they are trying to reduce the Pittsburgh Corps even further. Why are Pittsburgh and these rivers not as important to the Federal Government as other areas along the Ohio?

We had great river and rail transportation until after WW 2 so that highways weren't as important for the transport of goods and materials. However today's transportation system, for distance less than five hundred miles, is highways. That is because trucks, not rail are the short distance hauler and with on-time delivery.

The State Legislature created legislation to permit the Pennsylvania Turnpike Commission to design and construct highways in Western Pennsylvania. The Turnpike built the Beaver Valley Expressway, the Greensburg Bypass, portions of the Mon-Fayette Expressway and started the Southern Beltway. But where was the Federal Government? Very little federal funding has been given to support these developmental type highways.

Many environmentalists do not like urban sprawl. The Mon Valley has a golden opportunity to revive the old mill sites that are now "brown areas" in Pittsburgh and the many mill towns along the Mon River so natural surroundings will not be replaced with "urban sprawl".

Many people say that we have too many roads but unless streets, avenues, roads and highways are design to accommodate trucks, these sites will not support development. Ask any of the areas developers. Companies are going elsewhere where highways are already constructed and the sites are already prepared for development.

Cities can only support so many streets and highways to get people, goods and materials in and out of the city. Although transit systems do not support the movement of goods and materials, they can efficiently move passengers. For the first time recently, I saw transit people support highways and vice versa. We need both systems since they have a specific chore to accomplish. They are not in competition with each other; they supplement each other. But what is the Federal Government doing about funding the future of highways and transit? They want to reduced the total amount.

The Port Authority just opened another link to Pittsburgh from the South Hills and they are designing a continuation of the subway to the recreational center on the North Side. This requires Federal Funds and they have received help. However, we had a chance to design and construct the people mover system that is currently being used at the Pittsburgh International Airport and throughout the world and create a new transportation industry for the Pittsburgh region. We lost that opportunity.

Now we have another opportunity to create another transit industry that is called Maglev. Unfortunately, the Federal Government has delayed in selecting the finalist for a Maglev test section. The choice is Pittsburgh vs. Baltimore-Washington, D.C. If it truly is a test for weather, terrain and function, this is not contest. It should be Pittsburgh.

One of the major stops for the Maglev is the Pittsburgh International Airport (PIA). I also did not mention before that PENNDOT in conjunction with Allegheny County and the Federal Government designed and constructed the Southern Expressway. As you can see, all these forms of transportation are important but in today's global market, we also need air transportation. Airports can only function well if the other transportation systems are functioning well also because they require passengers, material and goods to be there on time.

The Federal Government is now complaining that airlines are not on schedule and it is causing a major air traffic control problem. The Federal Government spent millions, maybe billions on the Denver International Airport because it was a bottleneck. Now they are complaining about Chicago and Atlanta airports. The Pittsburgh International Airport was the first airport that was designed after the Federal Government repeal of regulated airlines. Regulated airports are where the government dictated who and how many planes would dock at each airport. When de-regulation took place, the hub system was borne by the airlines. USAirways choose Pittsburgh as one of their hubs.

PIA is more than the size of the two busiest airports in Chicago and Atlanta combined. Yet the Federal Government wants to increase the number of runways at these airports rather than placed them at PIA where land and gates are available. Why isn't the Federal Government thinking of those passengers who have to get through those congested airports, walk long distances and expect delays. PIA was design to accommodate both the airplane and the passenger, something that most airports do not do. When there are weather problems, where do the airlines land when they can't get to the east coast or elsewhere? They land at the Pittsburgh International Airport.

When USAirways wanted to combine with American Airlines, the Federal Government said no. When USAirways wanted to combine with United Airlines, The Federal Government said no. USAirways went bankrupt twice and is constantly reducing flights out of Pittsburgh, thus reducing the work force.

Why is Maglev important to

Pittsburgh? There are a number of reasons.

- One, it would provide transportation to the airport from outlying towns where short airplane rides are being dropped.
- Two, the passenger can enter the airport on a transit system at a more convenient time for the passenger since the transit system does not have to compete with the airspace of the long distant airplanes.
- The traveling public could leave their car near to their home and not have to be concerned about the traffic to & from airports.
- Maglev would provide short-term construction work.
- Maglev would provide long-term manufacturing work.

With airspace becoming more cluttered, another means of transportation to airports will be necessary in the future. Pittsburgh has a problem because the number of people who live in the Tri-State area isn't enough to support an airline, according to some. At least it has a difficult time competing with cities that have over six million population. This is also true of our sports teams.

But with the help of Maglev, traveling between PIA and many cities and towns in a large radius of the airport, our population will increase at the airport, the sports center, the health center and the downtown shopping and recreation center. This requires a different type of thinking, something that we sometimes lack and that is vision of the future.

Tom Stockhausen, VP of Maguire Group and a former Allegheny County planner told me many years ago that if we want passengers to take a transit system to the airport, we have to take care of their baggage at the beginning of transit travel. With the security today, this is more difficult but not impossible.

Do we have the funds to do all of this? Yes, but only if we want a future for our children and their children. When President Eisenhower announced in 1956 that the Federal Government was going to fund the Interstate System, he never said what the total cost was going to be. Had he mentioned the cost, it would have never been constructed. Over time, it was constructed without damaging our pocket books and it helped our pockets books even more.

A transit system cannot be built in small sections that are usable, like highways. A section of Maglev or any transit system has to be large enough to function completely on its own. This causes a much larger upfront cost that the general public has a difficult time in digesting.

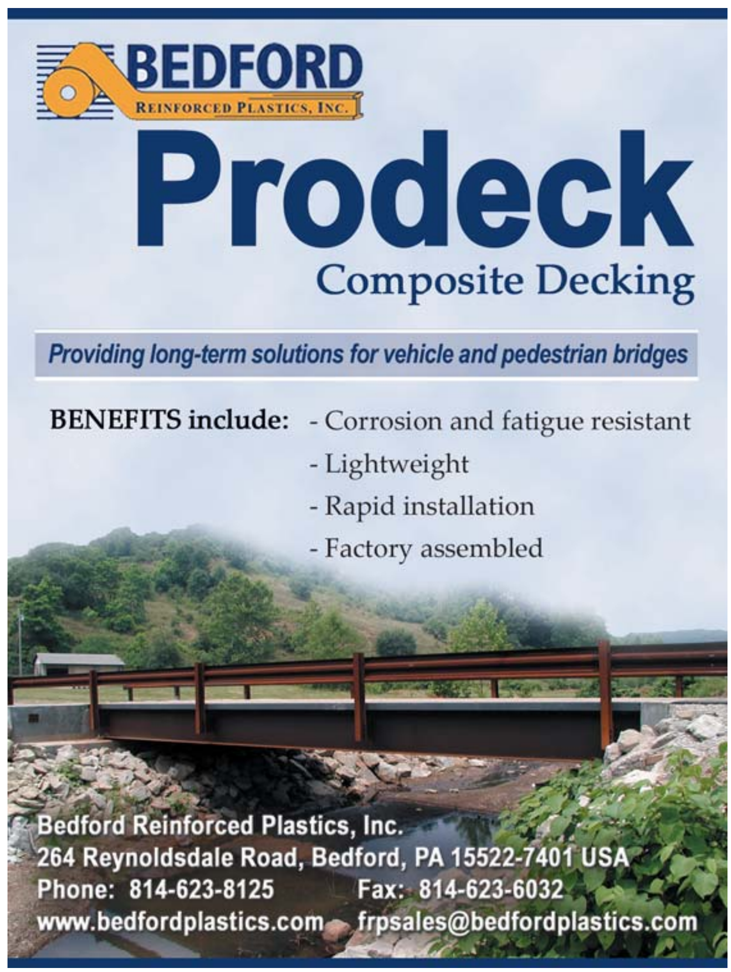
Pittsburgh's road system is mainly a spoke system and it worked well when it was the center of travel. Today, it is only one of the centers, with the airport, the sports center, the health centers and the many different work centers. That is way we cannot rely on just one or two types of transportation and just a spoke system of highways.

The construction of the Pittsburgh to Rt. 51Mon-Fayette Expressway with the Squirrel Hill bypass and the Southern beltway provides the connection to other centers of activity including the airport. This will provide a part of the beltway surrounding Pittsburgh. This does not take away traffic from the center city; it allows those who wish to use I-376 to enter the city without most of the traffic that wants to be south of the city and travel to the airport.

Years ago, Dave Zazworsky, a Turnpike Civil Engineer Consultant suggested that SR 9, the Turnpike's Northern Extension be converted to I-476. The Northern Extension extended from Philadelphia's I-476 or the Blue Route to Wilkes-Barre. Twenty-five years ago, there wasn't much traffic on it but it gradually became very active. More than five years ago when it officially became I-476 by the Federal Government, it became extremely busy and profitable. At the same, I suggested to PENNDOT and the Federal Government that I-376 from the Turnpike (I-76) at Monroeville be extended through Pittsburgh and over I-279, RT 22/30 and RT 60 back to the Turnpike (I-76) near the Pa/Ohio border. PENNDOT liked it so much that they wanted the I-376 designation extended up to I-80. As of today, the Federal Government has not approved this designation. Although it doesn't provide PENNDOT with additional funds, it does take the confusion of how to direct some one to the PIA. This can only help the driver. Isn't it about time we did something for the taxpayer?

If the Federal Government was truly interested in reducing the amount of oil (fuel) we are using, they should fund many small capital highway/street projects that reduce the time and increase the safety at many intersections by adding safe turning lanes, by coordinating traffic signals, by activating traffic signals and constructing passing lanes. There are some things that the State Legislature can do that do not cost a thing. That is making it illegal to park on a state highway or any street that is a main route with at least four lanes, any closer than 250 feet before and after an intersection. This would allow more traffic to pass through the interchange. Then a sign to merge should be placed so traffic can proceed safely. I prefer prohibiting all parking on all four or five lane streets that are main traffic routes.

Has the Federal Government abandoned Pittsburgh, if they haven't, they are doing a good job of proving they have. This is not a criticism of any administration since this has been going on for a long time. Don't you think that it is about time we all started to complain and support Pittsburgh and the TRI-State region to get a better share of the transportation systems funding in the United States?



The Perfect Storm

By Lisle E. Williams, PE, PLS,
Director of Infrastructure Project Development
DMJM+HARRIS, Inc., Pittsburgh, PA;
Construction Legislative Council, Transportation Committee

S. Brady St. Bridge, Dubois, PA (left)

Fort Duquesne Blvd. (right)

A State Liquid Fuels Tax Increase is Crucial.

An increase in the State Liquid Fuels Tax is vital to the Commonwealth's 40,000-mile highway system and its 22,000 bridges. This increase would offset Federal revenue losses that jeopardize planned improvements to the highway network, and address the challenges of meeting transit operation costs throughout the Keystone State.

There are currently numerous situations that, left unchecked, could converge in 2005 to create a "perfect storm" — jeopardizing Pennsylvania's future.

Are Conditions Right for a Perfect Storm?

- A potential 18 to 20-percent reduction in Federal highway funding for Pennsylvania in 2005 — *Passage of the President's highway bill could result in a loss of $200 - $300 million in annual appropriations.*
- Erosion of the buying power of the 3.5-cent increase passed in 1997 — *Even with this modest liquid fuels tax increase, the buying power of the 1997 revenue* increase has been offset by inflation.
- There is approximately a two-year lag before State Liquid Fuels Tax revenues affect contract awards for highway construction, highway maintenance and construction-related jobs — *Once a Liquid Fuels Tax increase is enacted, it will take nearly two years from the date of tax collection to the start of construction funded with these revenues. During that two-year period, conditions will continue to deteriorate.*
- Projected losses in Federal Liquid Fuels Tax revenues for Pennsylvania will result in an annual loss of approximately 14,000 construction and industry-related jobs — *The loss of jobs over several years will further jeopardize already precarious pension and health programs in the construction trades and place a strain on fragile workers' compensation funds.*
- The projected reduction of Federal revenues will further delay, and potentially reduce and/or cancel, many projects on PennDOT's Twelve-Year Transportation Program — *Twelve projects totaling $3 billion are currently being reevaluated, and 14 projects totaling $2 billion have been deferred indefinitely. These projects are essential for continued infrastructure maintenance and safety improvements, and for alleviating traffic congestion. In Pennsylvania, as in other states, the need for transportation system improvements exceeds available resources. Many bridges and roadways will continue to operate beyond their original intended design life. Failure to act now on a revenue increase will accelerate job losses and population decline.*
- Even at current funding levels, the need far exceeds the investment — *Federal studies (AASHTO) indicate that a 50% revenue increase is necessary to keep pace with current capacity requirements.*

If Not Now… When?

A recent increase in crude oil prices may lead some to believe that a tax increase should be postponed — *Delay, however, will only exacerbate the deteriorating condition of our infrastructure.*

- The last increase in state revenues was enacted seven years ago — *If an increase is not enacted at this time, inflation will continue to erode the currently available resources.*
- The State Legislature must enact a revenue increase after the November 2, 2004, presidential election, during the Lame Duck session.
- As an example, the State of Ohio recently enacted a 6-cent per gallon tax increase that will take affect at the rate of two cents each year. This additional revenue will be used to rebuild the Interstate

PAAC Stage II LRT (right)

Mon/Fayette Expressway (left)

PAAC Stage II LRT

system, and will also create good-paying blue and white collar jobs.

Why Act Now?

- Delay time for motorists on their home-to-work commute has increased.
- Economic development depends on a first-class transportation system — *The governor's economic stimulus package depends on adequate revenues for enhanced safety, increased capacity, and a sound transportation network.*
- As a result of road postings and truck restrictions, consumers have been paying more for goods and services due to the increased cost of delivery by truck.
- Pennsylvania has the third highest percentage of structurally deficient bridges in the country.
- With anticipated reductions in Federal highway funds, state action is necessary to sustain current construction and maintenance programs.
- A loss in highway revenues will result in the reduction or elimination of highway maintenance work, and Pennsylvania will once again become the "pothole capital of the country".
- Highway construction creates good-paying jobs — *It is estimated that between 44,000 and 47,000 jobs are created for each billion dollars of highway funds. In southwest Pennsylvania, just 12 miles of Mon/Fayette Expressway construction resulted in 750 manufacturing jobs in 12 companies, representing a 31 million-dollar investment in the Commonwealth.*
- In our "just-in-time" economy, increased truck traffic warrants additional safety, access, and capacity improvements — *82% of our commodities are moved by commercial trucks. Pennsylvania is called the Keystone State for a reason. Truck traffic to New England, the Southeast and the Midwestern United States must pass through Pennsylvania on their way to deliver or pick-up goods and materials. Highway improvements are, therefore, essential to ensure safety, provide additional capacity, and enhance Pennsylvania's economic competitiveness.*
- Gross truck weight limits continue to increase: from 66,000 GVW to 72,280 GVW, and currently to 80,000 GVW.
- Over 1,300 lives are lost each year on Pennsylvania highways — *A significant number of these fatalities can be attributed to improper and outdated highway geometrics and substandard safety features.*

Why Do We Need a Regional Leadership Coalition?

- There has not been a strong regional coalition between the Southwestern Pennsylvania Commission (SPC) members from urban areas and those from rural areas.
- As the Metropolitan Planning Organization (MPO) includes additional counties (currently 10), the rural area encompassed by the MPO continues to grow and accounts for more votes than Allegheny County and the City of Pittsburgh.
- Residents in rural areas do not always recognize and, more importantly, support funding for the unique needs of the central core — e.g., transit, public and educational facilities, airports, etc.
- Failure to establish a unified coalition has stymied the region's economic vitality and its ability to maximize state and Federal transportation dollars.

What Can We Do?

1. Focus on maximizing discretionary and Federal funds for the region's most important corridors

It is clear that needs dramatically outweigh existing resources. Available funding is limited, and passage of the next Federal Transportation Bill **will not** provide adequate funds for upgrading and improving the Commonwealth's infrastructure. Existing State DOT and Federal Transit Administration (FTA) funding resources, already stretched to the limit, will become even more overwhelmed by the increasing demand for highway and transit capital improvements and necessary interstate reconstruction. New forms of local transportation funding have been discussed by SPC Board members, but there is limited support.

2. Explore private/public funding options

Many important transportation infrastructure projects are stalled or incomplete due to funding issues. Among them:

- **The Mon/Fayette Expressway**, critical to the Mon Valley and Southwest Pennsylvania, will provide an impetus for economic growth. Completion requires over $1.5 billion; no funding source is currently identified.

MLK East Busway Bridge over S. Braddock Ave.

The Perfect Storm, continued

- **The Southern Beltway and the Findlay Connector** will reduce traffic congestion on the Parkway West, and make southern areas of the region accessible for further development.
- **Rapid Transit — Oakland to Downtown to Pittsburgh International Airport** — will improve transit operations in the corridor and upgrade the Parkway West, but close coordination with affected agencies is necessary.
- **An SR 28 Upgrade** is needed but there is disagreement between the River Life Task Force and PennDOT (FHWA) regarding those plans.
- **The I-279 and I-79 Missing Ramps** would provide additional interstate highway capacity.

3. **Identify an Allegheny County "Champion" to pursue additional funding for the region and advance critical projects; appoint a Transportation Expert to identify and promote key projects that provide system-to-system applications.**

The Transportation Committee of the Construction Legislative Council has identified many important projects in the region that need funding. These include:

- **The North Shore LRT Connector** has a 20% local funding commitment, but that funding package is only partially secured.
- **The "Missing Link" on the Martin Luther King Jr. East Busway** would provide a direct connection from the Busway to the Mon/Fayette Expressway. This connection would provide high-speed bus access from Monroeville to Downtown, and establish the Mon/Fayette Expressway as a multi-modal project.
- **Major transportation services to North Hills** would include the extension of the HOV facility north to I-279 and Wexford, and would include park-and-ride lots.
- **Maglev** is a major unfunded facility with high operation and maintenance costs. If this project is canceled or awarded to another city or region, the Federal government should be pressed to provide a "consolation prize" to the Pittsburgh region.
- **A Central Business District Disaster Evacuation Plan** is needed — the Mon/Fayette Expressway and the area's Interstate Highway System are key corridors. The terrorist attacks of September 11, 2001, and, closer to home, the effects of Hurricane Ivan on September 17, 2004, make it clear that a CBD Evacuation Plan is necessary to ensure the safety of our citizens.
- **Designation of I-376/I-279, SR 60 and SR 22/30 as a new Interstate Route.**
- **Critical unfunded projects on I-79 from the Ohio River to the I-279 split.**


Westmoreland Intermodal Facility

4. **Build consensus and provide political willpower to advance projects.**

There must be a unified consensus among elected officials, State and Federal agencies, community groups and the general public on the need for infrastructure improvements, and on the value of identified projects. Partisan politics and personal preferences must be discarded for the sake of our children and the region's future. The details of each project should be clearly defined and its benefits fully explained, so that all stakeholders see and understand its value.

If you agree that this region lags behind other parts of the country because it has under-invested in transportation infrastructure, your voice must be heard.

We can address these problems in two ways:

- Provide a multi-modal system that integrates the various modes of transportation
- Secure additional revenues to address the shortfall of available transportation funding for Pennsylvania

As engineers and industry professionals, we must stress the need for dedicated funding, not only to our colleagues, but to elected officials and others with influence to secure such funding. By taking action today we will ensure a better tomorrow for **all of us**, and for future generations.

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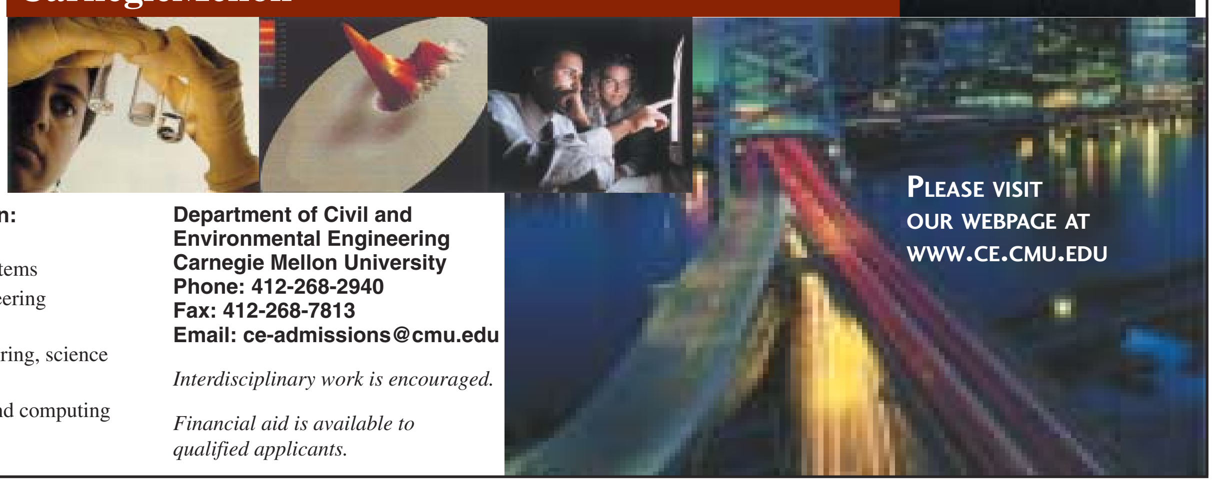

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Effect of Transportation Improvements to the Airport Corridor

By Dwight Schock
Assistant Vice President-Transit, Michael Baker Jr., Inc.

Improvements to Pittsburgh's Parkway West, long discussed and at last under way, may be creating some slowdowns today, but will have important long-term economic benefits for the Airport Corridor.

Many more proposals exist to improve the transportation corridor from Downtown to the Pittsburgh International Airport and to address clearly identified needs that motorists can see and use right now. But locating and securing the necessary funding has proven to be a significant stumbling block. The Moon Township-based, engineering and professional services company, Michael Baker Jr., Inc. (Baker) has long been involved with Airport Corridor projects and has provided a report on the effects of transportation improvements to this vital link between Pittsburgh and the rest of the world.

The comprehensive report, developed for Port Authority of Allegheny County, PENNDOT, the Southwestern Pennsylvania Commission, Allegheny County, and the City of Pittsburgh, titled, "Airport Multimodal Transportation Improvements: An Opportunity for Southwestern Pennsylvania," details exactly what is at stake should the transportation system in the airport corridor remain as is.

"The fact is that the Parkway West fares poorly when compared with modern transportation systems in the regions around the world that compete with Southwestern Pennsylvania for jobs," states the report. "The Parkway West is fifty years old, constrained by undersized tunnels and in some cases partial interchanges, experiences higher than statewide average accident rates, and is vastly overburdened by traffic.

"The current queue typically ends near Green Tree," the report continues. "By 2025, the back up will extend from the Fort Pitt Tunnels to I-79, never easing to Green Tree during the entire work day."

A task force comprising Port Authority of Allegheny County, Southwestern Pennsylvania Commission, PENNDOT, Allegheny County, the Allegheny County Airport Authority, and the City of Pittsburgh– led the study, which affirmed, "With the implementation of proposed improvements, the Parkway West will become a catalyst for growth and development in the region, rather than the obstacle it is today." Community and business leaders, as well as the public, provided specific input as the report took shape.

The proposed improvements were grouped into two main areas — Parkway West Widening/Bus Rapid Transit, and Airport Connector Light Rail Project.

Under the Parkway West Widening/Bus Rapid Transit category, specific recommended improvements include:

- Parkway West widening by one lane in each direction.
- Interchange improvements from the Fort Pitt Tunnels to Beaver County.
- Designation of the Parkway West as Interstate 376.
- Improvements to the "core area" between the Banksville Road interchange and Downtown Pittsburgh, which may include two new two-lane tunnels, adjacent to the existing Fort Pitt Tunnels, as well as interchange improvements at both ends of the tunnels.
- Bus Rapid Transit expansion to the current West Busway.
- Transportation system enhancements including roadway, trail, safety, Intelligent Transportation Systems and access improvements to further facilitate movement throughout the corridor.

Under the Airport Connector Light Rail Project category, specific recommended improvements include:

- Light rapid rail transit link between Downtown Pittsburgh and the airport.
- Linkage of the Downtown Subway, North Shore and South Hills LRT via the North Shore Connector currently under design.
- Improved transit service for local communities via reliable and frequent transportation to jobs, residences and commercial activity centers for the City of Pittsburgh, McKees Rocks, and the townships of Stowe, Kennedy, Robinson, Rosslyn Farms, Moon and Findlay.
- Transit-oriented land use enhancements in those communities.
- Opportunity to connect to Oakland and other corridors.

It's quite an ambitious set of plans, but the potential for economic benefit is every bit as ambitious.

"People have thought for years that we really need to do something along this corridor, but once it gets

started it can never get done fast enough," said Sally Haas, president of the Airport Area Chamber of Commerce. "So many years of waiting; hopefully, this is going to make the kind of improvements and the kind of economic difference we all want."

Among the possible improvements identified for the Parkway by the Study and its sponsors, are several projects that have either been started or are planned, including building missing ramps to connect the Parkway West to I-79, improvements to the Settlers Cabin and Campbell Run Road interchanges, and connection to the Pennsylvania Turnpike Commission's Southern Beltway.

As Baker worked with the task force, the question wasn't about building a new highway, but how to improve transportation to make the region more economically viable. The goal was to facilitate movement throughout the region, particularly between Downtown and the airport.

Baker and the task force determined that the economics of the situation dictated that widening the Parkway West made the most sense, because it not only connects Pittsburgh's Downtown and the airport, but the Parkway is also the lifeline for business along the corridor that connects to the rest of the region — Monroeville, the university community in Oakland, the Mon Valley and more. The bottom-line realization was that when the Parkway West is working well, all parts of our region benefit.

The report backs up that assertion, stating that development and redevelopment projects affecting thousands of jobs may be reduced or eliminated without making the necessary improvements to the airport corridor. Dozens of future developments and redevelopment plans in Beaver, Allegheny, Washington and Westmoreland counties rely on Parkway improvements, including university and hospital development in Oakland, redevelopment of the former LTV sites in Hazelwood and Aliquippa, development of the Intermodal Transport Center at Sony near New Stanton, and thousands of units of new residential development.

The lack of efficient transportation from the airport — whether by private vehicle or public transit — remains the single greatest obstacle to the economic gains this region has in its sights, according to the report. With some of the initial projects now under way, hope remains strong that the tide will begin to turn in favor of local business and economic development.

One of the report's recommendations would require virtually no — or very little — public funding, yet could make tremendous inroads in attracting new investment to the area. This is the simple designation of the entire length of the Parkway West as a federal Interstate highway.

"Getting a redesignation as an Interstate would be wonderful," said Haas. "Around here we all call it the Parkway West, but think about it — there is not one sign anywhere on that road that reads 'Parkway.' People coming in from out of town don't know what we're talking about.

"But beyond being able to give better directions to visitors, getting an Interstate designation could encourage and attract more development, because developers want to invest and build close to Interstate highways," she said.

"The Parkway West is a backbone of transportation for this entire region," said Haas. "It carries the main load. Our need for better transportation infrastructure and connectivity is driving these efforts, because the corridor remains closely tied to and is critical for the success of our community."

Michael G. Bock, a 1991 graduate of the Duquesne School of Law Evening Division is a partner and construction law practitioner with Schnader Harrison Segal & Lewis, LLP. He is a registered Professional Engineer and currently the 1st Vice President with the Engineers' Society of Western Pennsylvania (ESWP).

Michael G. Bock, P.E., Esquire…

…on the Combination of Engineering and Law:

"Throughout my prior career in engineering and construction, I was often involved with attorneys… usually with respect to contract negotiations or with respect to pursuit or defense of a construction claim. From those experiences, it appeared clear to me that an attorney with hands-on experience and substantive knowledge in engineering and construction areas could be especially effective and would have a real advantage in practicing construction industry law."

…on the Duquesne University School of Law Evening Division:

"With my J.D. degree in hand from Duquesne Law School's Evening division, I've been practicing construction law for approximately twelve years. I typically represent contractors, owners, design professionals and surety companies. I believe my clients appreciate the fact that I've 'been there' and can identify with their legal problems based on firsthand experience. This makes for a very effective and enjoyable working relationship. Also, I've found my legal skills, combined with my background in engineering and construction, to be a very marketable 'package' to construction industry clients."

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"The Welfare of the People is the Highest Law"

A Catalyst to the Future

By Louis D. Rocchini, PE and Sheri Cramblit, Maguire Group

Snarled traffic is costing the average urban traveler 46 hours a year, totaling 3.5 billion hours a year, a 187% increase from two decades ago, according to the Texas Transportation Institute's latest *Urban Mobility Report* released in September. And it's no better in the air. The number of people traveling by air is on the increase as well, with projections showing significant increase in travel delays over the next ten years due in part to capacity constraints and security delays. So what is the solution?

The answer may be a high-speed, high-tech ride of the future. While high speed trains have been operating in Europe and Asia for decades, and Amtrack's Acela on the Northeast Corridor for several years, they have wheels and tracks and seldom sustain speeds of 150 mph. .Although interest is continuing to grow in many states throughout the country as plans for high speed rail corridors are planned; high-speed trains are if anything a short term solution. Their speed is not great enough to lure passengers from air travel, or attract new commuters. As a result, the Europeans and Japanese have been developing maglev systems, short for magnetic levitation, capable of reaching speeds in excess of 300 mph., addressing a possible long term solution to ever increasing gridlock. Maglevis an entirely different form of transportation than most Americans are familiar with.

Maglev trains operate under the ancient principals of physics that opposites attract — opposite poles of two magnets attract and similar poles repel — using electromagnetic fields to propel the cars along a friction-free guideway at very high speeds. The maglev system is made up of dual guideways providing service in each direction. In 1968, an American team was granted a patent for a maglev design but when federal funding dried up in 1975, Japan and Germany leaped ahead in pursuit of this high-speed technology.

Thirty years after the American team began its research, Congress passed the "Transportation Equity Act for the 21st Century" which established the Magnetic Levitation Deployment Program to be administered by the Federal Railroad Administration (FRA). The intent of the program is to promote the development and construction of an alternative transportation system that utilizes magnetic levitation technology, at speeds in excess of 250 mph and a project at least 40 miles in length, so that it can be considered for implementation in a longer-distance corridor.

Seven sites were originally selected to submit proposals to the FRA for Maglev funding. In 2001, the FRA narrowed the competition to two finalists, Pennsylvania and Baltimore/Washington High-speed Maglev Projects, to build the first high-speed maglev transportation system in the United States. The remaining participants were encouraged to continue planning their projects and to pursue funding from other sources.

The PA High-speed Maglev Project is a Public/Private partnership between the Port Authority of Allegheny County (PAAC), Pennsylvania Department of Transportation (PennDOT), MAGLEV, Inc., and in cooperation with the FRA.

The 54 mile PA-Project links Pittsburgh International Airport with Greensburg in less than 35 minutes including stops in downtown Pittsburgh and Penn Hills/Monroeville with future extensions envisioned to reach throughout the state and eventually to the populous northeast corridor. The project will provide an excellent evaluation of the planning, design, building and operation of the high-speed maglev technology in the United States, as well as being the best location from which to deploy maglev across the nation.

Maglev Technology

The maglev technology of choice is the German Transrapid System, developed by Transrapid International. Transrapid is proven technology and has been under research and development since 1969. A test track has been in operation in Germany for over 20 years and reaches speeds in excess of 280 mph. Transrapid describes the Maglev as "the first fundamental innovation in the field of railway technology since the invention of the railroad".

Many see maglev as the only practical means for resolving current traffic congestion problems and meeting growing travel demands. Its supporters claim that maglev technology offers many advantages over traditional high-speed railways:

Reliability — The technology has proven to be extremely reliable. Because maglev vehicles are elevated and do not touch the guideways and there are no moving parts, there is little wear and tear and few opportunities for mechanical breakdowns and all controls and power systems have redundancy. Maglev is less susceptible to weather delays than flying or driving; it's relatively quiet and has low vibration levels.

Performance — Speed counts. Ridership on ground transportation systems increases markedly with speed. With maglev capable of reaching speeds in excess of 300 mph, it can be competitive with short airline trips, especially when factoring in the ability to provide origins/destinations of center city to center city.

A trip from Pittsburgh to Philadelphia would take less than 2 hours.

Safety — The maglev units wrap around the guideways which makes derailments impossible. The system runs on energized blocks that are only activated for the passing vehicle. The guideways between trains are deactivated preventing a collision. The elevated guideway eliminates grade crossings, removing the possibility of collisions with other modes.

Efficiency — Because there are no moving mechanical parts in the drive system and the vehicle floats above the guideway, there is no friction and therefore excellent energy efficiency.

Economics — When viewed in the context of airport expansion, high-speed rail, and major freeway widening, maglev is cost competitive. Maglev has the advantage of more flexibility and the ability to integrate with other modes of travel.

Maglev is suitable for transporting goods as well. For high-speed cargo transport, special cargo sections can be combined with passenger sections or assembled to/ from dedicated cargo trains. As the propulsion system is in the guideway, neither the length of the vehicle nor the payload affect the acceleration power.

Ride comfort — The ride is very smooth, also because there is no contact with the guideway. The system achieves rapid acceleration and deceleration and the guideway is designed (horizontal and vertical curves) for passenger comfort.

Environment — Approximately 96% of the alignment is proposed to be elevated thereby minimizing impacts to natural resources. The elevated guideway will also allow for the land beneath the guideway to continue to be used for such activities as farming. Maglev can move as many people as a 6 to 10 lane highway, which in urban areas would result in significantly less environmental impacts.

Why Pittsburgh

Investments in economic development are the future of this region. Therefore, it is important to look at the entire picture, envisioning what kind of transportation systems are needed to work together for the long term and, asking what investments should we be prioritizing over the next 20 years to make up this transit blueprint.

Pittsburgh is an ideal location for the first deployment of maglev technology in the United States. Pittsburgh's topography consisting of hills, valleys, rivers, along with its changing seasons provides the opportunity to fully assess maglev's ability to operate anywhere in the United States. This topography has also shaped Pittsburgh's transportation network. Because of the region's terrain, the transportation network relies on numerous tunnels and bridges which restrict traffic flow. Pittsburgh's major east-west access is the Parkway East (I-376) and the Parkway West (I-279) with traffic flow on these major highways restricted by the Squirrel Hill tunnel, the Fort Pitt Bridge and Fort Pitt Tunnel. With dense development adjacent to these highways, substantial widening to handle the current congestion is impractical. This highly congested east-west corridor provides the ideal opportunity to attract present auto users to a fast and reliable alternative transportation mode. The elevated guideway maglev system with its dedicated right-of-way would be ideal technology to help alleviate Pittsburgh's traffic problems.

Pittsburgh has the necessary technical and manufacturing expertise to "Americanize" the maglev system for U.S. application. The steel guideways are a crucial element to the system and involve an ultra precision manufacturing process. MAGLEV, Inc. has devoted years to developing a precision steel fabrication process for steel guideway beams. MAGLEV, Inc., under contract to the U.S. Department of Navy, has been working on the development of technology that would produce precision fabrication of hulls for Navy ships. This same technology could be applied to the precision fabrication of steel guideway beams for the maglev system. This, coupled with Pittsburgh's strong industrial background in the manufacturing and fabrication of steel, its technical expertise in software development, and other technical manufacturing skills in the region, make Pittsburgh a logical place for the fabrication of maglev technology.

The system will also create the start of an expanding regional system that will bring economic industrial growth and jobs to the region while serving as the impetus for revitalization of the area. The Pennsylvania Project is estimated to generate up to 10,000 temporary construction jobs in the region and 1,200 permanent jobs. These estimates do not include spin-off jobs from enhanced tourism and an enhanced business climate in southwestern Pennsylvania. Many of these will be manufacturing and fabrication jobs, related to an anticipated need for 200,000 tons of U.S. produced plate steel required to build the guideway. Western Pennsylvania could become the center for maglev technology and manufacturing in the U.S., recapturing the image of the City as a Leader of Industry.

The Future

An Environmental Impact Statement (EIS) for the Pennsylvania project is currently being prepared by the MSM Group (a joint venture of three locals firms – Maguire Group Inc., Skelly & Loy Inc., and McCormick Taylor Associates). Public hearings are expected to be held shortly, followed by the FEIS and a Record of Decision anticipated for mid 2005.

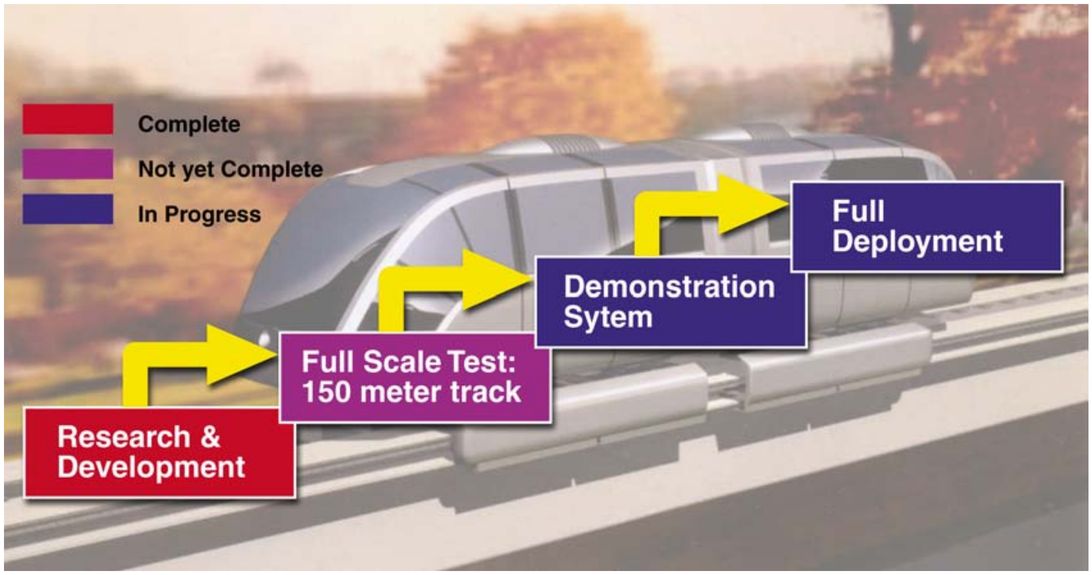
The future demands that some new solutions be implemented. The Chinese have leaped ahead with the first commercially operated maglev system connecting Shanghai's financial district with Pudong International Airport. In the United States, the race to the future is on. The federal government must remain an active partner working with private industry to develop and deploy a maglev system. Deployment of one or two maglev projects is needed to convince the nation that the technology is practical and to identify areas for improvement. It will also allow private industry to establish the production of maglev technology in the United States and Pittsburgh can be in the forefront of this new industry.

Where the high-speed train may take us depends on our vision for transportation and our communities in the future. Maglev is a new mode of transportation that will provide speed, frequency, and reliability that ultimately can change the travel patterns of Americans. Critics, stating the huge investment in the system will never pay off, may be missing the point. Yes, the system will cost billions of dollars to build, but the ride from the past into the future may be well worth it.

Creating an Urban Maglev Industry

By David O'Loughlin,
President, Urban Maglev Group

In 1992 a consortium of 32 industrial and financial companies was formed to develop an Urban Maglev system. The companies, called the Urban Maglev Group, are primarily based in the Pittsburgh area. They include General Atomics, Carnegie Mellon University, Lawrence Livermore National Laboratory, Hall Industries, Mackin Engineering Company, Sargent Electric Company, The International Brotherhood of Electrical Workers Pension Fund (IBEW), P.J. Dick, Union Switch and Signal, United States Maglev Development Corp., Booz-Allen and Hamilton, Mellon Bank and Western Pennsylvania Maglev Development Corporation.



Federal, State and Private Funding

Urban Maglev technology is being developed as part of the Urban Magnetic Levitation Transit Technology Development Program that is funded by the Transportation Equity Act for the 21st Century (TEA-21) through the Federal Transit Administration (FTA). The overall objective of the FTA's Low-Speed Maglev Program is to develop magnetic levitation technology that is a cost effective, reliable and environmentally sound transit option for urban mass transportation in the United States. Thirty-five million dollars of Federal funding has been appropriated for this program under the TEA-21 transportation funding bill approved in 1998. Eighteen million dollars has been awarded to the Urban Maglev Group, the largest single award of the Urban Maglev funding under TEA-21. Matching funds of $3.6 million have been provided to the Urban Maglev Group by the Pennsylvania Department of Transportation (PennDot) and the Pennsylvania Department of Community and Economic Development. Over $6.5 million of private funds have been provided by the Urban Maglev Group.

Staircase to Deployment

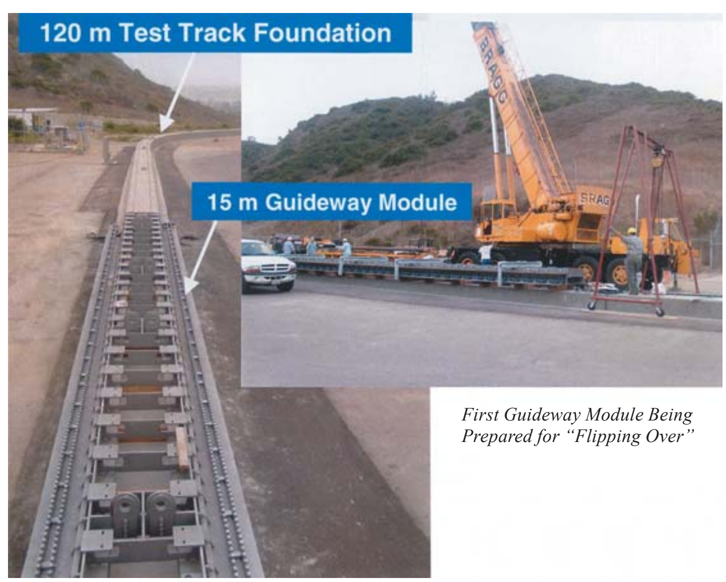
Step 1 — Proof of Levitation

The FTA and PennDot have utilized a "Staircase to Deployment" concept beginning with a $10 million in-depth Research and Development study which was completed in December of 2001. By constructing and operating a 12-foot wheel testing system simulating vehicle operating speeds of up to 100 miles per hour the study proved that levitation could be achieved utilizing permanent magnets. The study posited attractive benefits of Urban Maglev technology including the ability to operate in challenging terrain with steep grades of up to 10%, tight, 60-foot radius turns, all weather operation, low maintenance and rapid acceleration. Perhaps most significant is the study's conclusion that Urban Maglev can meet the environmental demands of the 21st Century of little or no air or noise pollution which enables the Urban Maglev System to be built on completely grade-separated, elevated guideways on single columns with four-foot bases supporting a double-track system. This means that Urban Maglev guideways could be built on City sidewalks by utilizing cantilevering.

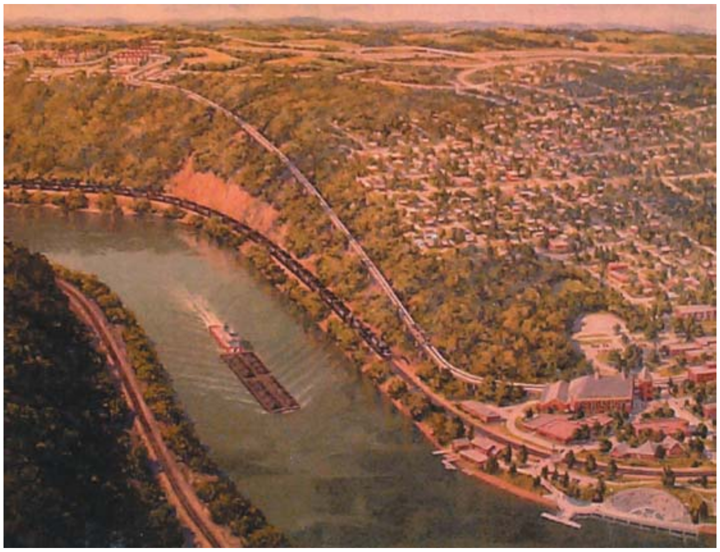
Projected cost savings over light rail systems that need to be placed underground to meet noise abatement requirements could be 50% or more. Operating and maintenance costs could be even greater due to the lack of friction created by the levitation of the vehicle above the guideway.

Step 2 — Test Track to Integrate Levitation, Propulsion and Guidance

Step 2 in the Stairway to Deployment is the full scale testing now underway in Dan Diego on a $10 million, 400-foot test track located at General Atomics. The Maglev chassis was built in Western Pennsylvania by Hall Industries and shipped by truck in August of 2003 to General Atomics. The testing, which will be completed in 2005, will validate the R&D study by successfully integrating magnetic levitation, propulsion and guidance. The vehicle will be levitated by permanent magnets and



First Guideway Module Being Prepared for "Flipping Over"



California University of Pennsylvania Demonstration Site

propelled by magnetic forces in the guideway utilizing a linear synchronous motor.

Step 3 — Construction of a Demonstration Test Facility at California University of Pennsylvania

Step 3 is the construction of a Demonstration Test Facility which provides a full-scale transit system that carries passengers on a regular basis in all weather conditions in challenging terrain. Federal funding support is being sought for a Demonstration Test Facility at California University of Pennsylvania that will connect California, PA with California University and a senior citizen's center. The 4-mile, double track system will link the town of California with the main campus and the University sports complex over 1 mile and a steep 7% grade away solving a difficult transportation and safety problem for the University as well as providing a linkage with the town and a senior citizen's center.

State matching funds have already been committed to the project.

Step 4 – Deployment

The final Step 4 in the Staircase to Deployment will be accomplished in urban settings such as in the city of Pittsburgh from the Universities and hospitals to downtown businesses and sports facilities. Colorado is studying the use of Urban Maglev technology from Denver to the Eagle County Airport to relieve traffic on I-70 for both tourist winter skiing activity and summer sports. Other cities are keenly interested in the success of the California University Demonstration Test Facility including Tulsa, Oklahoma City, San Diego, Irvine Santa Fe and Albuquerque. Other markets for Urban Maglev technology are the national parks and universities and colleges.

Awards

On October 14, 2004, the Urban Maglev Group and, more specifically, General Atomics and Lawrence Livermore National Laboratory (LLNL) were recognized for their "innovative research and development on the "Inductrack Magnetic Levitation System." Each year R&D Magazine recognizes the top 100 most technologically significant new products. This technology, designated Inductrack Magnetic Levitation System" was originally invented at LLNL and is being developed as part of the Urban Maglev program at General Atomics. Inductrack employs unpowered arrays of permanent magnets beneath the vehicle. When the train is in motion, the magnetic field from the permanent magnets generates levitation by interacting with a "track" made up of conductors assembled in an array that resembles a ladder with close packed rungs.

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Port Authority a Vital Part of the Local Economy

By Paul P. Skoutelas, P.E.
CEO, Port Authority of Allegheny County

Port Authority of Allegheny County's network of transportation services provides some 240,000 trips every weekday for residents of Allegheny County and portions of five surrounding counties. A 25-mile light rail transit system and 18.4 miles of exclusive busways are the backbone of a diverse system that also includes the Monongahela Incline and operations over the HOV lane of I-279 North and three dedicated bus lanes in the City of Pittsburgh.

The business of public transportation, however, is also the business of our local economy. Port Authority capital construction and service create and support jobs for local companies, encourage and support economic development and provide a vital link between businesses and their employees and customers.

Port Authority services do so much more than simply move people. We connect them to life. That connection is a vital one in the complex picture of our local economy, because it affects the ability of employees and consumers to play their respective roles in our daily commerce.

In addition, our capital program of almost $1 billion over the last decade has not only made possible more efficient transit services but has created or supported jobs for hundreds of local companies while fostering and complementing development that makes our community more vibrant.

Studies have shown the economic effects of investment in public transportation infrastructure go beyond improving mobility for all Americans. The American Public Transportation Association reports that every $10 million capital investment in public transportation sparks $30 million in economic returns through job creation or support, business sales and savings in transportation costs and productivity. Similarly, every $1 billion invested in infrastructure supports approximately 47,500 jobs.

Dollars from such capital investments flow to hundreds of industries, from specialized rail and bus construction firms and vehicle manufacturers to transportation planning firms and software suppliers, thereby promoting commerce vital to our economic growth.

Under these formulas, Port Authority's capital construction program of approximately $1 billion over the last decade has created or supported 47,500 jobs and sparked more than $3 billion in economic returns locally — significantly impacting and sustaining our region's economy. The planned North Shore Connector, a $381 million project that will extend the T light rail transit system to both the growing North Shore and to the David L. Lawrence Convention Center, will continue this positive effect.

In short, public transportation investments significantly impact our national and local economies by offering people the freedom to do either of two fundamental things — to earn money or to spend money.

Even after they are completed, Port Authority's capital investments have continued to be a factor in local economic development.

A study of Port Authority's Martin Luther King, Jr. East Busway found that 54 new developments with an assessed value of $302 million occurred along or near the facility in the first 13 years after it opened in 1983.

Similarly, planning for the West Busway that opened in 2000 included an agreement with the Borough of Carnegie that made possible the construction of its new municipal complex, including retail space, adjacent to Carnegie Station. That project also has fostered the retail development of a five-acre parcel along University Boulevard in Moon Township adjacent to Port Authority's University Boulevard Park and Ride Lot.

The importance they placed on public transit links helped Mellon Bank and PNC Bank decide to construct new facilities adjacent to the T in recent years. The $112 million Mellon Client Service Center was constructed adjacent to the Steel Plaza Station, while PNC's $110 million Firstside Center was constructed adjacent to Port Authority's First Avenue Station.

"In addition to investing in and encouraging economic development in the downtown Pittsburgh area, ease of access for our employees was a key factor in selecting a location for this important facility," PNC Bank president Sy Holzer said.

The North Shore Connector, which will extend from a relocated Gateway Center Station under Stanwix Street and the Allegheny River to Pittsburgh's North Shore and include a connection to the convention center, will also support existing and planned development while making possible future extensions to the west, north and east.

The project will provide convenient connections to persons traveling to or from the Carnegie Science Center, the Community College of Allegheny County, Heinz Field, PNC Park, the Heinz History Center, the Strip District and planned North Shore facilities that include a new amphitheater and buildings being constructed by Del Monte and Equitable Resources, among others.

Port Authority's critical role in transporting workers to and from their jobs is demonstrated by the fact more than half of all people traveling to Downtown Pittsburgh on an average weekday use public transit. Those who do not use public transit also benefit because our region's historically high level of transit usage continues to reduce pollution and congestion on local highways.

Port Authority has also worked hard to do its part in providing the transportation link that makes it possible for local residents to reenter the workforce.

Since the formation of strong partnerships with dozens of public and private organizations as part of the Allegheny County Welfare To Work Transportation Task Force, Port Authority has secured $25 million in federal, local and private grants to fund bus routes that are critical components of a countywide effort to promote the re-entry of welfare recipients into the workforce. An integral part of the process of obtaining that financing was Port Authority's lead role in engaging the Allegheny County business community and support services in the projects, identifying transportation barriers, investigating sustainable solutions and facilitating communication between partners.

In addition to successfully competing for Federal Department of Transportation funds, Port Authority also worked to secure funding from the Pennsylvania Department of Public Welfare, the Allegheny County Housing Authority and the Sanders Task Force and Three Rivers Workforce Investment Board, which oversee funding for local workforce development, economic development and housing initiatives.

Need for Balance Between Mobility, Cost and Impact

By Allen D. Biehler, P.E.
Secretary, Pennsylvania Department of Transportation

A few years back, the Sunday New York Times had a telling picture that accompanied a story about the challenges faced by a number of Third World countries. The photo showed frustrated drivers standing atop their trucks that were stranded deep above their tires in mud. Without mobility, a nation has little chance of competing.

Though we are blessed with the world's highest mobility standards and a matching level of economic prosperity, our nation and commonwealth are not without challenges as we manage transportation.

In Washington, Congress and the President are well into a second year without agreement on a new six-year transportation spending blueprint. Congress recently settled for another eight-month temporary funding extension. Left unresolved are thorny and pressing issues about how federal money will be allocated among the states and whether public transit, intercity passenger rail and rail freight are going to gain a place in a truly balanced transportation agenda.

One immediate impact of the national transportation myopia is the impending loss of the Three Rivers passenger train between Pittsburgh and Harrisburg. The Three Rivers and its sister train the Pennsylvanian had growing ridership. But as financially hard-pressed as Amtrak is, it had no choice but to start cutting, and this fabled passenger rail corridor — once home to the Broadway Limited — again faces loss of service.

Looking to our own situation, we find that Pennsylvania will be roughly $6 billion short of meeting all highway and bridge needs over the next six years. We have a big (40,000 miles of highways; 25,000 bridges), old, state maintained system and unrelenting customer expectations that those pavements will be smooth and the structures up to date.

A coalition of interests representing the construction industry and public transit are pushing the Governor and Legislature for more revenue. But with fuel prices at $2 a gallon and likely to stay there or go higher, it is going to be very tough to ask people to dig deeper for transportation.

Our role at PennDOT is to do the very best we can with available resources. From his first day in office, Gov. Edward G. Rendell relentlessly has ordered all of us in his Cabinet to slash expenses and improve value for taxpayers. At PennDOT, we have cut millions from overhead expenses and are implementing detailed programs to squeeze more efficiencies from our maintenance operations and retool the project delivery process.

Revitalizing Pennsylvania's cities and boroughs is high on Governor Rendell's agenda and transportation decisions loom large in that picture. We are at a point where we simply can't offer up the four-lane, limited access bypass as the preferred solution for our mobility issues. We can't afford it financially or physically. Instead, we are looking to "right size projects;" that is to find the balance between improved mobility, reasonable cost and favorable environmental and neighborhood impact. Three projects in southeastern Pennsylvania are going through such a review now. And we are working with Metropolitan Planning and Rural Planning Organizations to agree on such an approach for future updates to our Transportation Improvement Plans. We must also think harder about how we integrate transportation with the shape of our living spaces and reverse the trends that threaten our core communities, suburbs and rural townships.

We in this nation and Commonwealth are blessed that we don't face the daunting daily challenges of getting to market, job or home as represented in that photo in the Sunday Times. Still, we have tough decisions ahead. I am confident that at least we are weighing our options and, working together, we will make reasonable choices to keep all segments of our society mobile and prosperous.

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