The AIST Process Benchmarker™ — Improving the Bottom Line

Abstract

The APB is an online database that serves as an analytical tool for tracking various production metrics between coke-, iron- and steel-producing companies. This paper describes the APB system functionality, and discusses the steps taken to develop the system.

Author

Ryan Wolfred
staff engineer, Association for Iron & Steel Technology, Warrendale, Pa., USA
rwolfred@aist.org

The Association for Iron & Steel Technology (AIST) has partnered with Management Science Associates Inc. (MSA) to develop the AIST Process Benchmarker™ (APB). The APB is an online database that serves as an analytical tool for tracking various production metrics between coke-, iron- and steel-producing companies. The mission of AIST is "to advance the technical development, production, processing and application of iron and steel," and the APB is one of the primary initiatives to actively pursue this goal. The system is being developed by the AIST Technology Committees to improve the collective performance of the global industry through the sharing of key performance indicators (KPIs) among peers, while maintaining the confidentiality of sensitive company data. This paper will give the reader some general knowledge of corporate benchmarking practices, describe the APB system functionality, and discuss the steps taken to develop the system.

Background and History of Benchmarking

The term "benchmark," as a noun, was coined by early land surveyors. It refers to a fixed reference point whose location was known with great accuracy and from which other measurements were then made. The term "benchmarking" appeared in the late 1970s and became common practice by the mid- to late-'80s. Benchmarking involves the comparison of one's own practices, processes, policies and/or procedures to industry peers. The intent is to identify and quantify one's own strengths/weaknesses, as well as determine ways to act upon and improve them. Most large, successful companies utilize some form of benchmarking to continually track, learn about and improve upon their internal processes to stay on the leading edge of their industry.

Although the APB platform is new, the process of industry benchmarking is not, having long been conducted in North America by the American Iron and Steel Institute (AISI) as part of their Manufacturing Committee activities. With the formal integration of the AISI and AIST committee activities in 2008, the process of industry benchmarking has now evolved into the APB system. In June 2011, AIST partnered with MSA to develop the APB system, which is based on MSA's proven Raw Material Data Aggregation Service™ (RMDAS). For nearly 10 years, RMDAS has been used to securely and confidentially track ferrous scrap prices and volume data across the steel industry.

Value of Benchmarking

Benchmarking proves to be an extremely effective tool for many businesses, small or large. In most industries, benchmarking is quickly evolving from being just a good idea into a required tactic for a competitive and

sustainable industry. With the aggressive pace of globalization and technological advancement in the 21st century, online benchmarking is an easy and affordable method to improve the bottom line. An effective, long-term benchmarking program can allow companies to:

- Benchmark KPIs for specific operations against industry norms.
- Identify opportunities for improvement and set performance expectations.
- Focus research and development to improve internal technical processes.
- Enhance corporate profitability and overall industry sustainability.

Perhaps the most important product of widespread benchmarking is the development of an industry mindset of continuous evaluation and improvement. This mindset has been essential for most, if not, all technological advancement throughout history.

System Overview

The AIST Process Benchmarker allows producer members to compare specific operating parameters in a multitude of combinations and formats. The user-friendly, subscriber-only database system gives producers the ability to generate and view many different reports, charts, tables and even raw data, all of which can be exported to a variety of standard formats for use in presentations, status reports, technical papers, etc. These comparisons may be for a given time period, a correlated look at several operating parameters together, views comparing similar facilities or operations, and other alternatives. The APB's reporting tool generates charts and graphs based on operator-selectable parameters, Technology Committee-specific standard reports, and a per-user configurable dashboard, allowing users to identify opportunities for improvement with clear and concise information.

The APB operates on a server hosted by Management Science Associates Inc. and is accessed from a participant workstation over the Internet through the AIST website, AIST.org/APB. Since this is an Internet-based service, the system can be accessed from virtually anywhere without the need to download, install and update software packages. Data security is provided through the use of individual login accounts, the use of secure socket layer (SSL) connections, and other system-wide security settings. The APB has the ability to mask all participating companies or identify comparative locations and companies, as pre-determined by the relevant AIST Technology Committee. The system is designed to electronically receive current and historical participant data. To ensure data integrity, all data entering the system is validated, cleansed and warehoused in a master database. To ensure fairness, the amount of data a company can retrieve from the system is commensurate with the data provided by that company.

How the APB Works

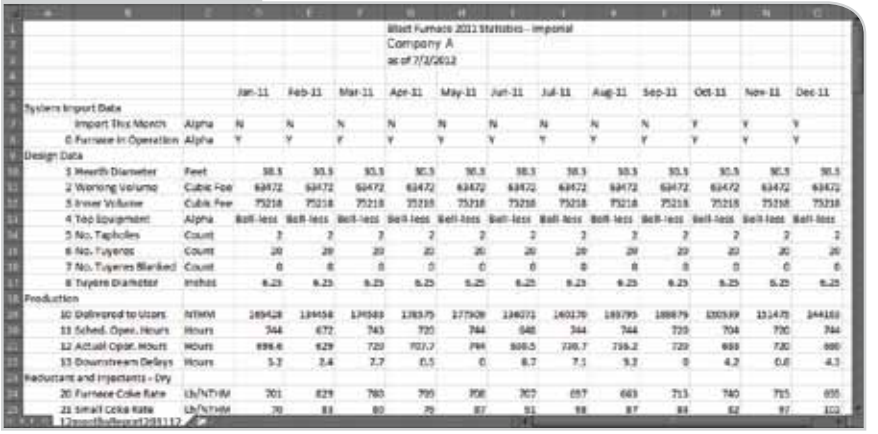
Terminology — Some terminology is commonly used when discussing the APB:

- **Module** — Refers to an individual subset within the APB, which is tailored to a particular AIST Technology Committee and steel manufacturing process (e.g., Ironmaking Technology Committee → Blast Furnace Module, and Cokemaking Technology Committee → Coke Oven Module, etc.).
- **Location** — Refers to the geographical location of a plant, mill, battery, etc. (e.g., U. S. Steel – Gary Works, ArcelorMittal Burns Harbor, etc.)
- **Facility** — Refers to an individual operating unit (e.g., blast furnace, EAF, BOF, etc.). There can be multiple facilities at any particular location. For example, ArcelorMittal has three blast furnaces at their Hamilton, Ont., Canada, location (#2, #3 and #4), each of which is considered an individual facility.
- **Key Parameters** — User-definable groupings of parameters that are of interest to the user. If an individual regularly views a collection of certain parameters, these can be saved for easy access in the future.
- **Key Facility Group** — Very similar to the Key Parameters, Key Facilities are groupings of facilities that are of particular interest to the user, whether by company, furnace size, equipment used, end product, geographical location, or other.
- **Key Aggregation Group** — This serves as a tool for selecting individual, as well as groups of, facilities to aggregate data.
- **Saved Query** — Creating a saved query will save all the criteria of a particular ad-hoc graph or table. Saved queries allow particularly useful charts and reports to be generated quickly and easily. They can also be used to customize the dashboard, which will be discussed later in this paper.
- **Percent Data Required** — This percentage is determined by each Technology Committee when developing a module. It is the minimum percentage of data, from the total number of parameters in the module, which each facility must submit per time period to gain access to similar data from other users.

Importing — The APB will generate a 12-month import template for any given facility. This simple spreadsheet will permit the user to collect and assemble the data offline prior to uploading into the APB. When generating the template, the system pulls all the available data from the previous 12-month period, based on the selected end date, and populates the appropriate fields. This not only provides a frame of reference for the user when inputting the new data, but also allows the user to correct and update any errors that may have occurred in prior months' data.

In most cases, users will be importing only one month of data at a time. However, the ability to import up to 12 consecutive months of data at one time is provided. This becomes useful if the user is populating the system with large amounts of historical data, or for the user who wishes to import data on a quarterly or semi-annual basis. Figure 1 shows part of an import template for someone wishing to upload data for the fourth quarter of 2011. Upon import, the APB reads the values in the row labeled "Import this month," and then proceeds to validate and import the data for all selected months.

Figure 1

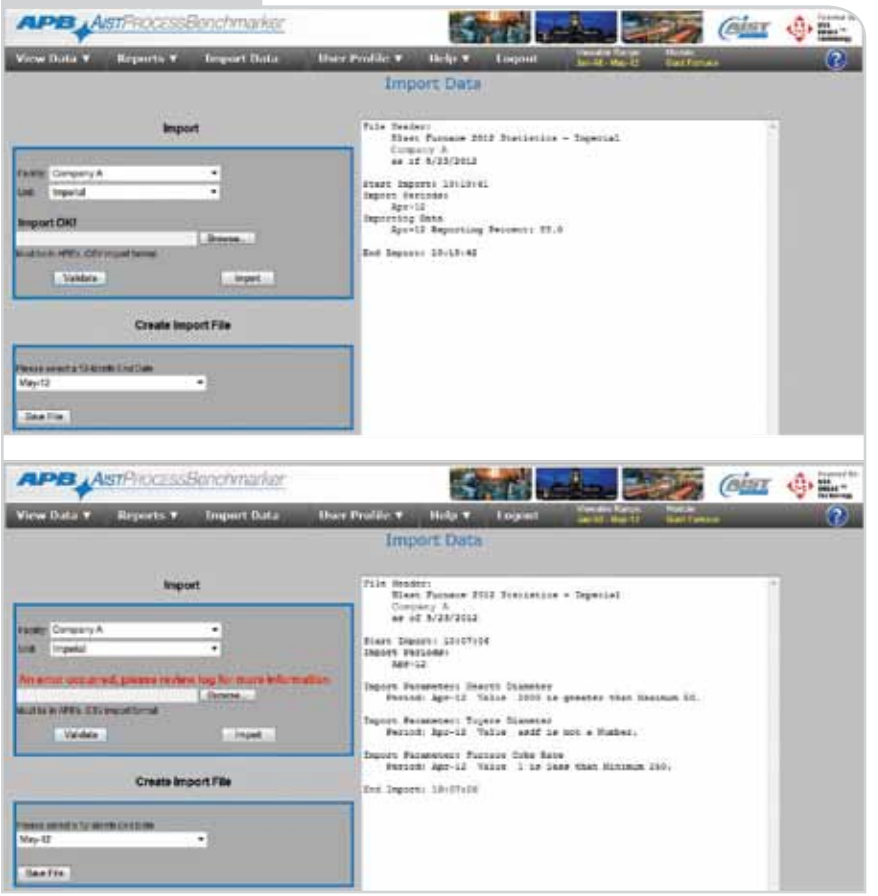


Example import file.

Upon a successful import, a log will display the months that were imported and the percentage of data that was imported with respect to the total number of parameters in that module. Should the data contain gross errors or typos, they will be caught by the APB's data validation feature. When data falls outside the predefined ranges or is the wrong data type altogether, the information is not imported into the system. Instead, the user receives an error message, along with an error log, describing exactly what failed and why. The user can then re-open the data file, correct the necessary fields, and re-import the data. Figure 2 shows both successful and failed import attempts.

Dashboard — The dashboard is the first screen that is loaded after logging into the APB. It is a user-customizable interface with four charts of particular interest to the user, as well as a participation report and system message. The dashboard is designed to provide the user with key data, without having to navigate through the system. If an individual finds a particular ad-hoc report useful and wishes to view it on a regular basis, the report may be saved to the dashboard. The date ranges for all charts on the dashboard automatically update, so every time a user logs on, the most recent data is presented. The participation report displays the number of facilities from each company that have provided their data for the most recent two months. A more detailed report, showing the actual percentage of data submitted for each facility, can be obtained by clicking on this tool from the dashboard. In fact, the user may click to expand any of the charts for a more detailed view of the data. Additional information can be gained by mousing over any of the data points on the chart. A text box will pop up, displaying the actual value of the parameter, as well as the facility and time period for the value. In addition to expanding the charts, users may click to see the raw data grid used to

Figure 2



Successful (top) vs. failed (bottom) import attempts.

Figure 3

Example dashboard.

generate the chart. An example dashboard is shown in Figure 3.

Ad-Hoc Querying — The APB provides significant flexibility to generate custom graphs and charts, based on user-selected criteria. The three primary ad-hoc querying tools offered are "Per Month," "Aggregated" and "Histogram." Within these tools, users have the ability to create and save groupings of key parameters, facilities and aggregation groups, as outlined previously. Such groupings may be defined by the relevant Technology Committee and provided to every user as a set of generic/default groupings. Users can also create as many of their own, unique groupings as they wish. This allows for quick and easy comparisons of data that is meaningful to each user.

The Per Month tab is a way of generating/viewing data for particular parameters and facilities on a month-to-month basis. Users can specify a start date, end date, unit system, parameters and facilities for which they wish to view data. From there, the user can choose to view a graphical representation or the raw data itself. Graphical representations can be saved as an image file or copied directly into another program, such as Microsoft Word® or Excel®. Raw data can be copied and pasted into an Excel spreadsheet for further analysis. Figure 4 shows a Per Month graph of the parameter "Delivered to Users" for eight different facilities over the period of July–December 2011.

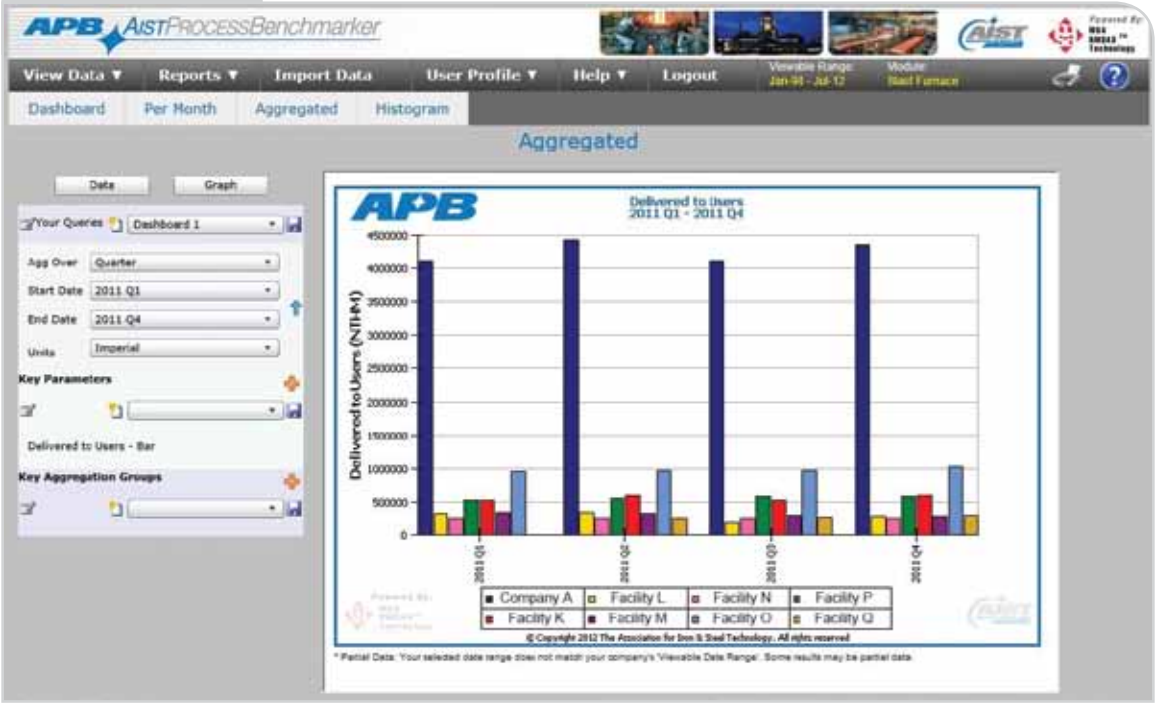
Figure 4

Per Month graph.

The Aggregated tab functions in a similar manner to the Per Month tab; however, in addition to viewing the data on a monthly basis, the data can also be viewed as an aggregate across quarterly or yearly time frames. Aggregate values for groupings of multiple facilities may also be generated. For example, a user may wish to see how his/her facility compares to the "company average" for a particular parameter. Figure 5 shows an Aggregated graph where the user has chosen the parameter "Delivered to Users," aggregated quarterly, for an entire company and seven individual facilities.

The Histogram tab provides an effective tool to compare a company against industry peers. This feature sorts facilities from greatest to

Figure 5



Aggregated graph.

Figure 6

Histogram chart.

least for the particular parameter(s) of interest. As with the Per Month and Aggregated sub-tabs, users can generate both raw data and graphical views. Figure 6 shows an example Histogram chart for the parameter "Delivered to Users" for 14 individual facilities over the period of January–December 2008.

Standard Reports — The APB provides three standard reporting tools: 12-Month Report, Facility/Parameter Report and Participation Report. The standard reporting tools offer less flexibility than the ad-hoc reporting tools; however, they are equally as useful. All standard reports are exportable to a variety of file formats, including: XML, CSV, MHTML, PDF, XLS and DOC.

The 12-Month Report provides monthly values for every parameter at a given facility over a 12-month period. It also displays the 12-month aggregated value for each parameter. The user must simply specify the facility, 12-month end date and unit type. Figure 7 shows a portion of a 12-month report.

The Facility/Parameter Report will display one value per parameter, per facility, aggregated over a certain time frame. The user must specify a start date, end date, facilities, parameters and unit type. An example Facility/Parameter Report is shown in Figure 8.

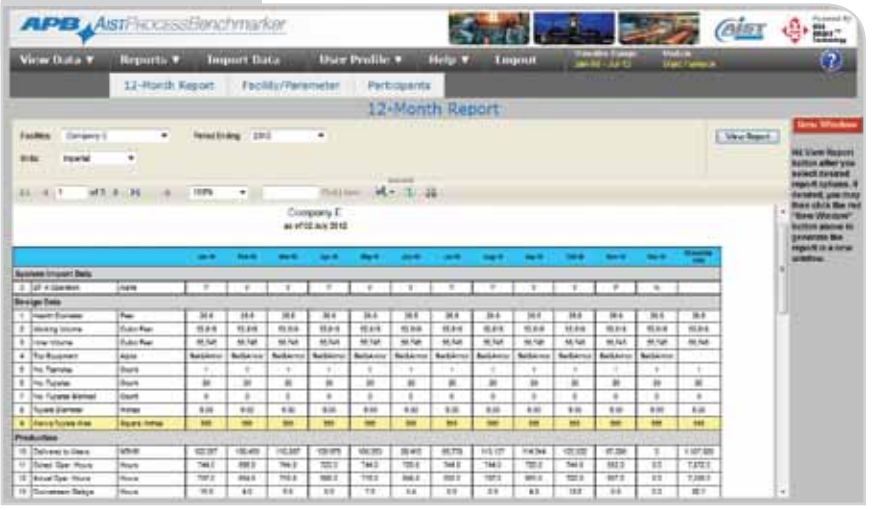
The Participation Report lets the user know which facilities have provided data for any given period, as well as the percentage of total parameters they have imported. This is useful for determining what companies are being compared. The amount of data provided is displayed for each facility over a 12-month period from the end date specified by the user. Figure 9 shows a portion of a Participation Report.

Module Development Process

While the technical software details (i.e., coding) of the APB are handled by MSA's software engineers, it is the responsibility of the AIST Technology Committee members to determine what parameters are to be included in the module, and how the data will be compared. Typically, committee members will assign one to three "data masters" who will take the lead in defining the module's parameters. Once drafted, the parameters are reviewed by the rest of the committee, final revisions are made, and the software engineer begins development of the module. Items that need to be established for each parameter in the system include:

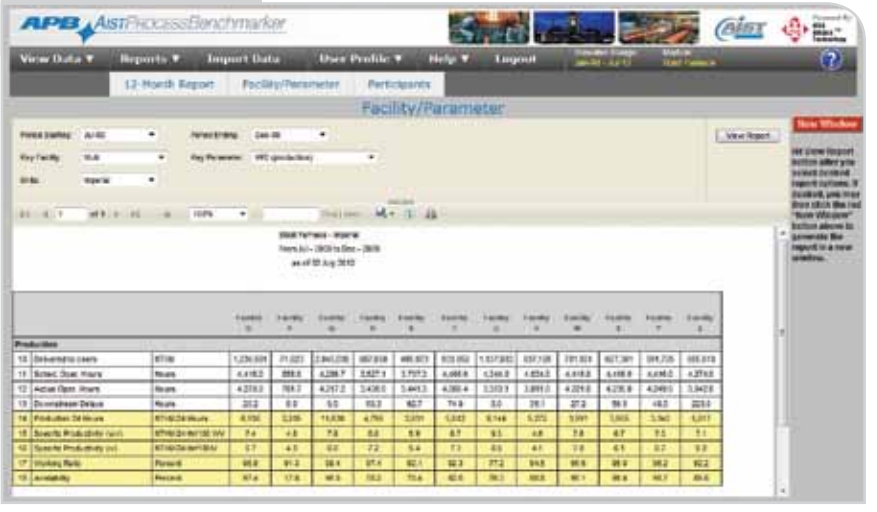
- **Category** — A group of similar parameters for easier navigation within the ad-hoc querying tools.
- **Parameter Name** — A unique label for identifying the parameter.
- **Parameter Short Name** — With limited space in the legends of some of the charts and graphs, this is a label containing 12 characters or fewer that is used for each parameter when it is displayed in a legend.
- **Metric Unit** — Unit of measure for the parameter in the metric unit system.
- **Imperial Unit** — Unit of measure for the parameter in the Imperial unit system.

Figure 7



12-Month Report.

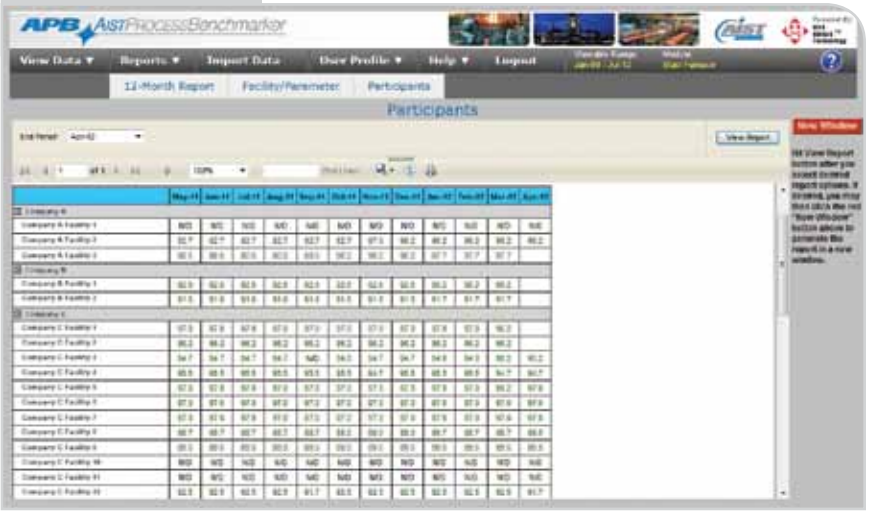
Figure 8



Facility/Parameter Report.

- **Data Type** — There are four options for a parameter's data type:
  - Integer (whole number).
  - Floating point (number with one or more decimal places).
  - Character (any character string with or without numbers).
  - Date (Mar-98, Apr-98, etc.).
- **Significant Digits** — This field applies only to parameters of the "Floating point" data type and specifies the number of places after the decimal point.
- **Min Value** — The minimum allowable value for the parameter. Used for data validation upon import.
- **Max Value** — The maximum allowable value for the parameter. Used for data validation upon import.
- **Aggregation Type** — This is how the data is treated when viewing a single value aggregated across multiple months and/or facilities. There are seven possible aggregation types:
  - Sum — The total of all values for the specified time period and facility group.
  - Weighted Average — Value is weighted based on another parameter, usually some form of total production.
  - Mean — A straight average of the values.
  - Min — The smallest value for that parameter.
  - Max — The largest value for that parameter.
  - Last In — The last value input for the time period. This is typically used for parameters that are character strings and, therefore, cannot undergo any type of mathematical aggregation.
  - None — No aggregated values are displayed for this parameter.
- **Calculation** — If a parameter is a calculated value, the calculation formula must be specified by the Technology Committee. Calculated parameters are not required for import, but are instead generated by the APB after the required data is supplied.
- **Required** — Is every user required to input this parameter for every import?
- **Report If No Production** — Are users still required to input this parameter, even if their operating unit was not in production for that month?

Figure 9



Participation Report.

Once modules are developed, select committee members are granted access to test the beta version before it is released to the public. In addition to the ad-hoc testing by committee members, every module must undergo a Factory Acceptance Test (FAT). The FAT consists of many individual itemized tests designed to cover every aspect and function of that module of the APB. The purpose is to verify that the APB module operates as it should and sufficient functionality has been achieved.

Module Descriptions

As of the writing of this paper, six APB modules have been released and are currently online:

Coke Oven — Developed by members of the Cokemaking Technology Committee, this module gives coke oven users the ability to track various types of information that are key to operational excellence. The parameters span areas of general information, such as: net tons/push and coking rate; quality-related data of the coke produced, such as moisture, volatile matter, ash, sulfur, phosphorus and alkalis; physical properties, such as stability and hardness; as well as the various sizing characteristics. Information related to coal charged will include percent volatile matter, ash, fixed carbon, etc., and measurements of wet bulk density and other coal parameters. In addition to the previously reported byproduct data, such as tar quality index, ash and moisture, H_2S and light oil BTX (benzene, toluene and xylene) and tar yields, additional byproduct data is being compiled to enhance the value of the program.

Blast Furnace — Developed by members of the Ironmaking Technology Committee, this module provides users with the ability to track parameters ranging from blast furnace design criteria and production statistics, to reductants/injectants, burdens/fluxes, tuyere configurations, top gas specifications, tapping data, slag data, hot metal chemical content and temperature, and others. Users have the ability to compare parameters from multiple furnaces simultaneously in a variety of combinations, both in tabular and graph formats.

Basic Oxygen Furnace — Developed by members of the Oxygen Steelmaking Technology Committee,

this module provides users the ability to track parameters, including hot metal supply, vessel additions via the hoppers, oxygen supply data, charging facility equipment, converter information, combustion system equipment, fume treatment equipment, dynamic control systems, ladle information, product carbon levels, specific gas consumption, metallic charge data, fluxes used, liquid steel/product output, hot metal charged chemical makeup, thermal aspects, converter refractories, dust produced, slag composition and general data.

Electric Arc Furnace — Developed by members of the Electric Steelmaking Technology Committee, this module gives EAF users the ability to track parameters relating to electric steelmaking technology, including: heat cycle time, carbon analysis, scrap addition/consumption, flux addition, consumables and refractories, electrical and chemical energy inputs, and production performance.

Continuous Slab Caster — Developed by members of the Continuous Casting Technology Committee, this module provides the flat rolled steel producer the ability to measure key process variables with parameters covering caster production values such as: casting speed-time-width, average superheat, cast grade mix, caster dimensions, slag control, mold operations, and caster machine specifications.

Hot Rolling Mill — Developed by members of the Hot Sheet Rolling Technology Committee, this module will be used by hot rolling mill operators to track parameters pertaining to the hot sheet rolling process. The parameters will cover availability and reliability data, such as: scheduled maintenance, gross rolling hours, unscheduled delay time, etc.; production totals, such as: throughput rate, total finished tons, percent excess, etc.; caster and meltshop data, such as: caster speed, average slab thickness, etc.; yield data, such as: percent coiled/non-coiled product, scale yield loss, cobble yield loss, etc.; product mix data, such as: percent high/medium/low/ultralow-carbon product, percent stainless product, etc.; energy consumption data, such as: furnace BTU/ton, electricity consumption, etc.; general production data, such as: average width, thickness, coil weight, etc.; and roll shop data, such as: total stock removed, roll type, laminar performance, etc.

Cold Rolling Mill — Developed by members of the Cold Sheet Rolling Technology Committee, this module will provide the ability to benchmark parameters relating to the cold sheet rolling process. The parameters to be tracked include production data, such as: operating turns, total charge tons, number of coils charged, etc.; size data, such as: average gauge, average width, etc.; delay data, such as: percent total delays, mechanical delays, electrical delays, etc.; usage data, such as: acid consumption, rolling oil consumption, etc.; as well as mix data, such as: percent product to coating facility, percent product with coating, etc.

Galvanizing Line — Developed by members of the Galvanizing Technology Committee, this module is able to track parameters important to the steel galvanizing process. The parameters span various arenas, including production metrics, such as: operating hours, total charged tons, total produced tons, etc.; sizing data, such as: average gauge, width, coil size charged, etc.; delay data, such as: percent mechanical delays, percent electrical delays, number of line stops per 30,000 tons produced; efficiency data, such as: furnace gas, hydrogen, and nitrogen consumption per ton of product; and other performance measures, such as: rejection rate, salvage rate, pot equipment campaign life, etc.

Future Work

In addition to the above, the AIST Technology Committees intend to develop more modules to eventually encompass the full spectrum of iron and steel manufacturing technologies. Additional modules currently envisioned will include, but are not limited to:

- Continuous Shape Caster.
- Rod and Bar Rolling Mill.
- Plate Rolling Mill.
- Maintenance and Reliability.

Along with the development of future modules, work will continue to improve the functionality and overall value of the existing modules. Such improvements might include the addition of parameters to be tracked, additional charts and/or reporting tools, as well as other system-wide enhancements.

Summary

The AIST Process Benchmarker is being developed by the AIST Technology Committees to serve as an industry-leading benchmarking tool for iron and steel. Much work has gone into ensuring the APB is intuitive and user-friendly, yet still a flexible and powerful analytical tool. Achieving this balance, while keeping data security at the forefront, has been the focus of the APB project from the start. It is anticipated that the system will meet or exceed every end user's expectations and represent an invaluable contribution to the welfare and sustainability of the global steel industry.

Additional Information

For additional perspective on the APB system architecture, readers may refer to a paper published in the *AISTech 2012 Conference Proceedings* entitled, "The Development and Technology of the AIST Process Benchmarker," authored by Patrick Gallagher and Noah Wolf-Johnston of MSA.[1]

Details on how to get involved with the APB can be found at AIST.org/APB or by contacting AIST's Ryan Wolfred (rwolfred@aist.org).

Acknowledgments

The author would like to thank a number of Technology Committee "data masters" for their input and assistance with developing the modules: Fred Rorick, Yun Li, Mike McCoy, Cam Howey, Toni Brayton, Rob Carlin, Sam Matson, Allen Rogers, Rudolf Moravec, Scott Starr and Tom Weiler. The author would also like to thank Noah Wolf-Johnston, Todd Zahniser, Jeralyn Brown, Patrick Gallagher, Tracy Brown, and the other MSA staff for their cooperation and dedicated work on this project. Furthermore, the author would like to thank his colleagues at AIST for their assistance with this and other APB-related pieces.

Reference

1. P.J. Gallagher and N.D. Wolf-Johnston, "The Development and Technology of the AIST Process Benchmarker (APB)," *AISTech 2012 Conference Proceedings,* Atlanta, Ga., May 2012. ✦