

Chapter 1

SAS Process Intelligence

Overview

Chapter Contents

Overview	9
Welcome to SAS Process Intelligence	9
What Is SAS Process Intelligence?	10
SAS Process Intelligence Architecture	12
Overview of SAS Process Intelligence Architecture	12
SAS Process Intelligence Components	12
SAS Process Intelligence Layers	15
A Useful Process Scenario	17
References	21

Chapter 1

SAS Process Intelligence

Overview

Overview

Welcome to SAS Process Intelligence

SAS Process Intelligence provides comprehensive capabilities that exploit highly dimensional, time-based data to facilitate improvement in the quality of both tangible products and intangible services. For the manufacturing of tangible products, this data can be thought to originate from “products,” “processes,” and “equipment.” During manufacturing, measurements are taken at each operation and the related attributes of the operation, such as the process, the product, and the equipment used, are recorded. SAS Process Intelligence integrates data from all of these sources, and analytically exploits the information in the data to provide the intelligence needed to efficiently and effectively manage your business.

Functionally, SAS Process Intelligence can initialize the solution with

- legacy data from your business
- imbedded performance expectations, specifications, and/or statistical rules unique to your business
- analytical offerings that you supplement with additional ad hoc and predefined automated analytical tools specific to your business

Once initialized, SAS Process Intelligence enables you to

- automatically monitor your products, processes, and equipment for performance issues
- immediately and proactively flag for review any significant exceptions to the business rules
- automatically notify individuals who are responsible to investigate and resolve exceptions
- automatically issue the analytical context of an exception to a knowledge management repository
- provide exploratory or reactive ad hoc analyses, and store the results with the correct context in a knowledge management repository
- use the knowledge management repository to support collaborative learning and problem solving within and between teams

Each business has different products, processes, and equipment, as well as unique quality management objectives. Therefore, SAS Process Intelligence must be configured to meet your unique business needs. Your experience with the solution may differ somewhat from the functionality that is described in this document. To illustrate the capabilities of SAS Process Intelligence, the examples are based on manufacturing a tangible product. A [semiconductor manufacturing scenario](#) is used throughout the documentation. When service delivery is the business goal, the analogous scenarios should be evident.

What Is SAS Process Intelligence?

SAS Process Intelligence is comprised of components that manage the storage, extraction, and analysis of your integrated data, and publish output to an external knowledge management repository. These components include the Information Store for data storage, the Navigator for data access, the Discoverer for a user interface for reactive data analysis, the Agent for proactive data analysis, and the Collaborative Space as the collaborative environment where results are published.

SAS Process Intelligence uses SAS/Warehouse Administrator software to support information storage through a prebuilt set of data warehouse environments. These environments control the loading of all relevant data, the data analyses in the Agent, and the summarization process that creates custom reports and user interface support tables.

Analyzing Data with SAS Process Intelligence

SAS Process Intelligence provides two methods to analyze your product and process data:

- proactive analysis via the Agent component
- reactive analysis via the Discoverer component

Once your data is analyzed, you can use the Collaborative Space to access published results and cooperatively work on issues that were identified in both the proactive and the reactive data analysis.

Proactive Data Analysis

As new data enters the Information Store, the Agent automatically analyzes the data and monitors trends that signal a need for further investigation. SAS Process Intelligence stores the results of the proactive data analysis in the Information Store and also automatically publishes the results that violate your business rules to the Collaborative Space. The responsible analysts and managers are notified to initiate containment or improvement action.

Reactive Data Analysis

The Discoverer provides the Web-based user interface for you to conduct exploratory and ad hoc data analysis. The user interface offers standard statistical analysis methods, as well as customized analytical tasks that are part of your site's implementation of SAS Process Intelligence.

Specialized knowledge of where the data originated, data extraction techniques (via SQL), or the underlying structure of the Information Store is not required. The Web-based user interface enables you to seamlessly interact with a set of server side query components that are designed to extract and manipulate the data that SAS Process Intelligence requires for the analysis.

You have the ability to iteratively refine the data extraction request so that SAS Process Intelligence investigates relevant physical locations, product or process conditions, or historical data and events. Results from the reactive analysis are also retained in the Collaborative Space.

Working with the Analytical Results in the Collaborative Space

After you publish results to the Collaborative Space, problem solving and collaborative communication can occur. The Collaborative Space enables dispersed teams to work on common problems and supports corporate memory through searches within the repository for past similar problems and their solutions. SAS Process Intelligence interacts with any knowledge management (KM) software that is compliant with the WebDAV standards (such as Intraspect or Microsoft SharePoint Portal Server).

SAS Process Intelligence Architecture

Overview of SAS Process Intelligence Architecture

The architecture of SAS Process Intelligence includes a variety of components that are integrated so that the data flows seamlessly through the solution. [Figure 1.1](#) provides an overview of the architecture of SAS Process Intelligence.

SAS Process Intelligence Components

The following list describes the various components in SAS Process Intelligence:

- Information Store
- Navigator
- Discoverer
- Agent
- Collaborative Space

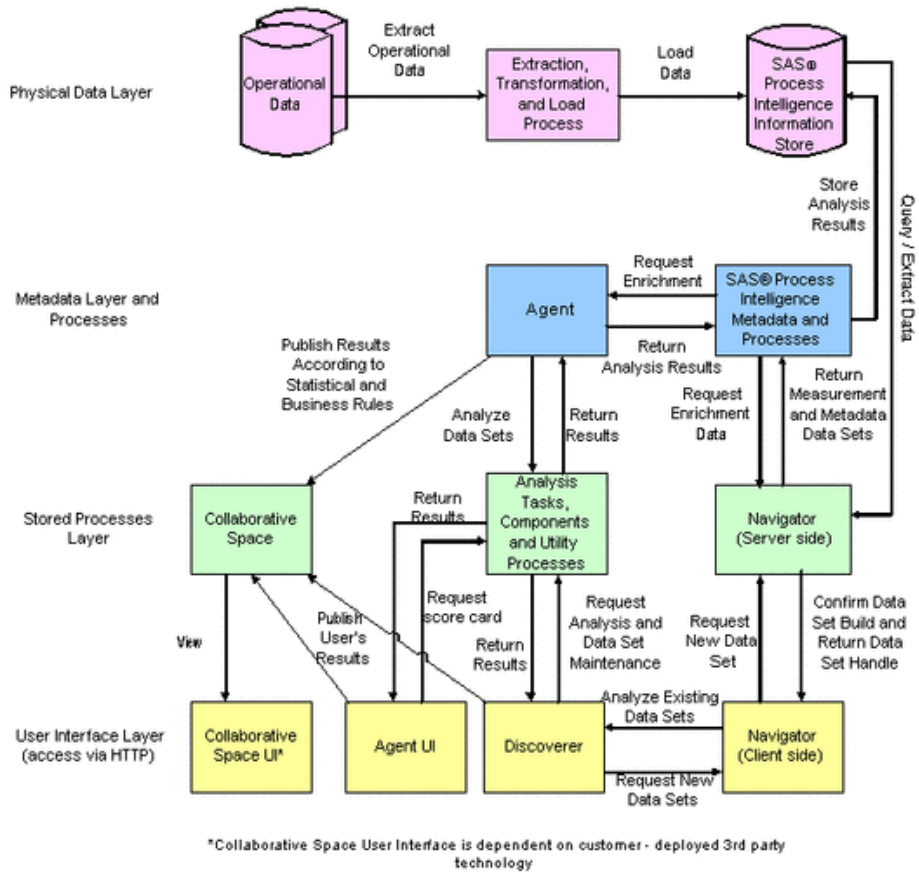


Figure 1.1. Overview of the Solution Architecture and Data Flow

Information Store

The Information Store is the data warehouse foundation for the solution. The Universal Data Model (UDM) for process, product, and equipment data and performance metrics provides the basis for all analysis and report generation. SAS Process Intelligence stores your business metadata in the Information Store to provide analysis rules for consistent evaluation and reporting.

Navigator

The Navigator provides intuitive navigation of the data in the Information Store. With knowledge of the structure and the types of analysis important for each metric, the Navigator enables you to easily choose the subset of data that you are most interested in for analysis in the Discoverer. The ability to download the data for other analysis purposes (such as Enterprise Miner software, JMP Software, Enterprise Guide software, Microsoft Excel, or other spreadsheet software capable of opening a comma-separated file) is also available.

Discoverer

The Discoverer provides an interactive graphical user interface that you use to conduct structured data analysis. Specifically designed for time-oriented data, the Discoverer is a Web client that exploits the business and analytical rules stored in the Information Store to ensure consistent reports.

Agent

The Agent monitors the data that flows into the Information Store and surfaces key issues and trends. The Agent examines your process and product metrics, sifting through millions of analysis results. Analysis results that are flagged by business and analytical rules are published to the Collaborative Space. Subscribers to this knowledge repository are automatically notified when the new information needs their attention.

Collaborative Space

The Collaborative Space provides the collaboration environment for SAS Process Intelligence. Reports generated by the Agent are automatically published to the Collaborative Space, while reports from the Discoverer are optionally published. The Collaborative Space enables team learning.

Note: Search capabilities and other knowledge management functionalities are dependent on the knowledge management software that you deploy. For information on the knowledge management repository that is available at your installation, check with your site administrator.

SAS Process Intelligence Layers

The architecture for SAS Process Intelligence has a number of different layers. [Figure 1.1](#) identifies the layers and shows the relationship between them.

Physical Data Layer

The physical data layer is the repository for your time-based data. The physical data can originate on any RDBM system that SAS/Access software supports. You can use SAS DATA step custom access programs to support the conversion of other types of operational data such as flat files and binary files. You can also use SAS to build custom data entry solutions that handle the conversion of paper-based operational data.

Metadata Layer and Processes

The metadata layer supports the Information Store and extract-transform-load (ETL) process. There are three logical groupings of the metadata. These groupings are

- Process Intelligence Metadata Tables Area
- Load Area - Universal Data Model
- Enrichment Area - Agent Output Tables

The Process Intelligence Metadata Tables Area contains the information that defines the Application Metadata and the User Metadata.

The Load Area provides a location to detail the data extraction, transformation, and loading of source data from the physical data layer into the SAS Process Intelligence detail measurements tables and dimensional tables. The Load Area also includes tools to populate the “subgroup” tables. These fact tables consist of various summarized statistics that are derived from the detail fact tables.

The Enrichment Area contains the metadata to drive the Agent batch processing and stores these results in summary tables in the Information Store.

Within the metadata layer is a logical data model that uses a constellation schema. Constellation schemas consist of multiple star schemas that conform to a set of common dimensions. Star schemas consist of fact tables (measurements) described by dimension tables (context: who, what, where, when, etc.). Primary and foreign keys relate the fact tables and dimension tables.

Stored Processes Layer

The SAS Process Intelligence stored processes layer (or SAS application layer) contains the components responsible for the data preparation and the stored processes that are responsible for performing the analysis. The results of the analysis are transported back to the user interface layer. The user interface layer is responsible for the user interface look and how the results are presented to you.

User Interface Layer

The user interface layer provides Web-based access to parts of the Navigator, the Discoverer, the Agent, and the Collaborative Space. You invoke the SAS Process Intelligence user interface with your Web browser (either Microsoft Internet Explorer 5.5 SP2, or Internet Explorer 6.0 SP1). The interface is built with DHTML behaviors, JavaScript, and JavaServer Pages (JSP). The interface is designed as a highly interactive, zero desktop install environment within a thin client.

A Useful Process Scenario

The capabilities of SAS Process Intelligence are shown throughout this document by analyzing sample data that is derived from a semiconductor manufacturing process. Semiconductor manufacturing utilizes a set of complex, sequential processes to produce a sophisticated product at a low cost. The industry is heavily dependent on data collection and analysis to monitor and improve quality. Many industries today are striving to achieve this same level of analytical sophistication. Thus, the semiconductor industry is an excellent candidate to demonstrate the capabilities of SAS Process Intelligence. This approach is intended to aid your understanding, not to imply any limitations on the applicability of SAS Process Intelligence to other products or services.

To enhance your understanding of how to use SAS Process Intelligence to analyze data and derive value from an integrated product and process perspective, a brief overview of the semiconductor product and process is provided.

The Product

Semiconductor manufacturing is complex, so the data scenarios shown with SAS Process Intelligence are simplified to aid clarity. In the *front-end* of the process, wafer fabrication produces completed silicon *wafers*, each of which carries between 50 and 50,000 semiconductor units, usually called *die*. In the *back-end* of the process after wafer fabrication is complete, the wafers are separated between their die to make individual semiconductor devices or *chips*. Then each chip is packaged and assembled, usually with other chips or components, to produce a final, functional end product.

Intrinsic to wafer fabrication is a hierarchical product structure, since die reside on wafers. To aid the movement of material through the factory or fab, wafers are often grouped together in batches or *lots*, so that three levels in the product hierarchy may exist. To manufacture completed wafers, the material moves along a specific path or *route*, which consists of many steps or *operations* that act together to produce the desired result. [Figure 1.2](#) and [Figure 1.3](#) summarize the wafer fabrication process.

At the heart of wafer fabrication is the repeated process of pattern transfer, where the specific pattern used defines the electrical properties of the die

or chip, and thus the final product. Typically, a given wafer or lot contains material for a single product only.

The Process of Pattern Transfer

Typically, semiconductor manufacturing follows the following summarized operational sequence:

1. The lot of wafers are cut from an ingot, cleaned, and polished. Next, a nonconducting layer of silicon dioxide is grown or deposited on the surface of the silicon wafer.
2. The silicon dioxide layer is covered with a photosensitive chemical film called a photoresist.
3. The photoresist is exposed to ultraviolet light that has been passed through a patterned plate, mask, or reticle. The photoresist areas that were exposed to the light are developed, or hardened.
4. Unexposed areas of photoresist are etched away to reveal the silicon dioxide base below. The base and the silicon layer below are further etched to specified depths.
5. The photoresist hardened by this process of photolithography is then stripped away, leaving a three-dimensional structure on the wafer that replicates the circuit design originally presented in the patterned mask.
6. The electrical conductivity of certain areas of the wafer are further altered by manipulating them with chemicals and heat (called doping). More photolithography, using different masks, followed by more etching and doping may be repeated numerous times on the same wafer. This process produces a more complex integrated circuit as the wafer continues to move through the operations on the specified route.
7. To create conducting paths between the components etched into the die, the wafer is overlaid with a thin layer of metal, and the lithography and the etching process is repeated to remove all but the thin conducting pathways. Sometimes several layers of conductors, separated by insulators, are deposited.
8. Once this recursive process of photoresist application, expose, develop, etch, strip, and doping is completed, the wafer is tested and later divided into individual die (Davidson 1999).

The wafer fabrication process is illustrated in Figure 1.2 and Figure 1.3.

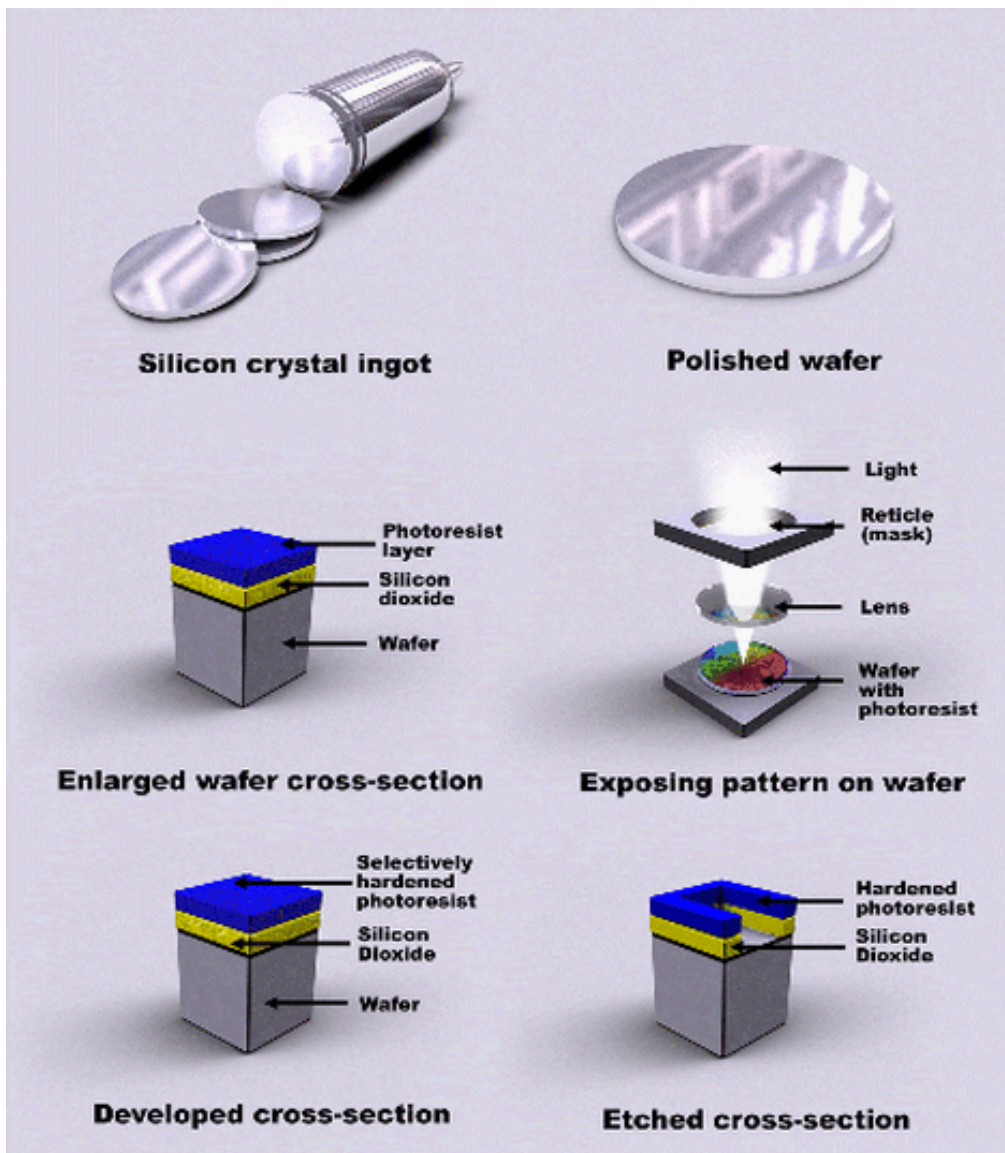


Figure 1.2. The Wafer Fabrication Process (adapted from Anthes 2002)

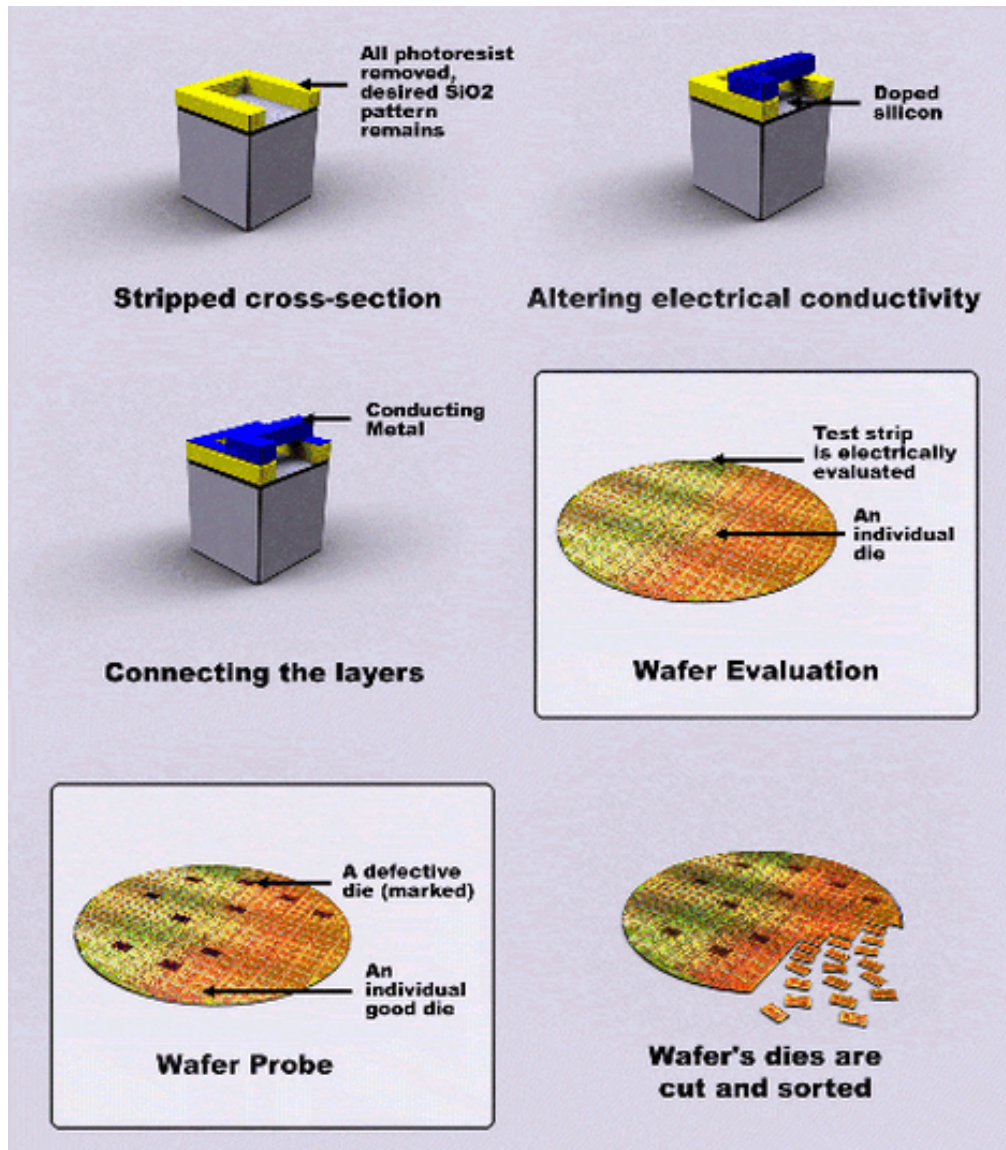


Figure 1.3. The Wafer Fabrication Process (continued)

The Quality Question

An analyst or manager must determine that the process steps or raw materials perform optimally in order to yield acceptable product. The wafer is tested for conformance to specifications, both before and after sawing the wafer into individual chips, and the data from the test operation(s) is analyzed.

This document uses examples and sample data from an operation called **Wafer Evaluation**. The objective of this operation is to electrically interrogate the wafer at selected test points and under specified conditions. Additionally, examples and sample data are included for a second operation related to quality assessment called **Wafer Probe**. The objective of this operation is to determine the electrical characteristics of individual chips on the wafer, and to sort them into categories based on functionality. Finally, the document includes sample data for a third operation, **Final Test**, which, as the name implies, tests the functionality of the final packaged product.

Refer to [Appendix B](#), “Sample Data” for additional details on the sample products and related sample data.

References

- Anthes, Gary H. “Making Microchips,” *Computerworld*, July 8, 2002. [www.computerworld.com/hardwaretopics/hardware/story/0,10801,72461,00.html].
- Davidson, Michael W. (1999), “Interactive Java Tutorials: Building a Transistor,” National High Magnetic Field Laboratory, Florida State University. [www.micro.magnet.fsu.edu/electromag/java/transistor/].

