synchronization device from the process stations are indicative of a status or statuses associated with each of the one or more products, as determined by process stations, at respective positions along the processing line. The product status synchronization device is configured to track the statuses assigned to each product by the process stations, temporally align the statuses conveyed by the signals, and to deliver a control signal at appropriate times to a downstream station (e.g., a reject station) for final disposition of the products.

[0005] In this way, a product status synchronization device (e.g., appliance) is described that may readily be deployed in manufacturing environments for synchronizing and combining outputs from multiple, asynchronous manufacturing process systems. For example, the product status synchronization device may be used to combine output signals from multiple machine vision systems or other inspection systems spaced at arbitrary positions on a manufacturing line. The device synchronizes and combines the individual decision outputs from each system to form a single final output, such as pass or reject final status, for any given product under inspection, and drives the output at the correct time to control any downstream reject station. The product status synchronization device provides a simple yet elegant, low cost device for deployment in any manufacturing environment. Furthermore, the product status synchronization device provides a user interface and other semi-automated mechanisms for easily configuring the temporal alignment of the signals, as well as the output control signal delivered to the reject station, based on the physical distance each of the process stations are located relative to some predetermined location along the processing line.

[0006] As one example, the disclosure is directed to a device comprising: a product status synchronization device comprising a plurality of input ports and an encoder input, each of the input ports coupled to one of a plurality of registers and configured to receive a signal indicative of a status assigned to a product by one of a plurality of process stations, and to register the status assigned to the product into the one of the plurality of registers coupled to the input port, wherein one or more of the plurality of process stations are located at different distances from a predetermined location along a processing line and are configured to asynchronously process one or more products moving through the processing line, wherein each of the plurality of registers is coupled to a different one of the plurality of input ports and has a register length, wherein the register length for each register is configured to have a length corresponding to a distance between the one of the plurality of process stations that is configured to be coupled to the input port coupled to the register and the predetermined location along the processing line, each register configured to track a plurality of statuses that have been registered into the register by the input port coupled to the register, and wherein the encoder input is configured to receive a movement signal indicative of movement of the one or more products through the processing line, and to shift the plurality of statuses registered in each of the plurality of registers based on the movement signal.

[0007] As another example, the disclosure is directed to a method comprising:

receiving, at a product status synchronization device, a first signal indicative of a first status assigned to a product by a first process performed on the product at a first process station, the first process station located at a first distance from a predetermined location along a processing line; registering the first status into a first register included in the product status synchronization device, the first register configured to have a first register length corresponding to the first distance and a having a first register last bit position; receiving, at the product status synchronization device, at least one additional signal indicative of a second status assigned to the product by a second process performed on the product at a second process station, the second process station located at a second distance from a predetermined location along a processing line, and wherein the second distance is different from the first distance; registering the second status into a second register included in the product status synchronization device, the second register configured to have a second register length corresponding to the second distance and a having a second register last bit position; shifting the first status through the first register and shifting the second status through the second register based on a movement signal indicative of movement of the product through the processing line so that the first status is shifted into the first register last bit position and the second status is shifted into the second register last bit position when the product arrives at the predetermined location, wherein the first register and the second register are provided as a generic logic gate array (GAL) device; and determining, by the product status synchronization device, a final status for the product based on the first status provided at the first register last bit position and the second status provided at the second register last bit position.

[0008] As an additional example, the disclosure is directed to a method comprising: assigning a separate register of a plurality of registers provided within a product tracking status circuit to a given and different one of a plurality of process stations provided at different positions along a processing line; moving a calibration product through the processing line, and generating a product present signal at each process station when the calibration product arrives at that process station; receiving, at the product status synchronization device, each of the product present signals indicating that the calibration product has arrived at each of the process stations; tracking, at the product status synchronization device, a number of encoder pulses associated with moving the calibration product from each of the plurality of process stations to a predetermined location along the processing line; and for each of the separate registers, setting a register length for the separate register based on the number of encoder pulses associated with tracking the moving of the calibration product from the process station assigned to the separate register to the predetermined location.

[0009] As an additional example, the disclosure is directed to a system comprising a processing line having a plurality of process stations positioned at one or more different locations along a processing line, the processing line configured to move one or more products through the processing line and to provide processing of the one more products at the plurality of process stations, each process station configured to provide an output signal indicative of a status assigned to a product of the one or more products processed by that process station; and a product status synchronization device comprising a plurality of input ports and an encoder input, each of the input ports coupled to one of the plurality of process stations and to one of a plurality of registers, and configured to receive a signal indicative of the status assigned to a product process by the process station coupled to that input port, and to register the status assigned to the product into the registers coupled to the input port, wherein each of the plurality of process stations are located at different distances from a predetermined location along the processing line and are configured to asynchronously process one or more products moving through the processing line, wherein each of the plurality of registers is coupled to a different one of the plurality of input ports and having a register length, wherein the register length for each register is configured to have a bit length corresponding to a

WHAT IS CLAIMED IS:

1. A device comprising:

a product status synchronization device comprising a plurality of input ports and an encoder input, each of the input ports coupled to one of a plurality of registers and configured to receive a signal indicative of a status assigned to a product by one of a plurality of process stations, and to register the status assigned to the product into the one of the plurality of registers coupled to the input port, wherein one or more of the plurality of process stations are located at different distances from a predetermined location along a processing line and are configured to asynchronously process one or more products moving through the processing line,

wherein each of the plurality of registers is coupled to a different one of the plurality of input ports and has a register length, wherein the register length for each register is configured to have a length corresponding to a distance between the one of the plurality of process stations that is configured to be coupled to the input port coupled to the register and the predetermined location along the processing line, each register configured to track a plurality of statuses that have been registered into the register by the input port coupled to the register, and

wherein the encoder input is configured to receive a movement signal indicative of movement of the one or more products through the processing line, and to shift the plurality of statuses registered in each of the plurality of registers based on the movement signal.

2. The device of claim 1,

wherein each of the plurality of registers comprises a final bit position and the final bit position of each of the plurality of registers aligns with the final bit position of every other one of the final bit positions, and

wherein the product status synchronization device product status is configured to determine a final status for a product that has arrived at the predetermined location based on a plurality of statuses indicated for the product at each of the final bit positions.

3. The device of claim 2, wherein the final status of the product is determined by performing a logical "OR" function using the plurality of statuses provided at each of the final bit positions for the product as inputs to the logical "OR" function.

4. The device of claim 2, wherein the final status of the product is determined based at least in part on a multiple-bit value provided as one of the plurality of statuses for the product by at least one of the final bit positions.

5. The device of claim 1, the product status synchronization device further comprising:

a status output configured to provide a status output signal indicative of a status associated with a given one of the one or more products, the status based on a combination of statuses provided by the plurality of registers for the given one of the one or more products, the status output signal indicative of the status associated with the given one of the one or more products configured to be provided as the given one of the one or more products arrives at the predetermined location of the processing line.

6. The device of claim 1, wherein the plurality of registers comprises a plurality of first-in-first-out ("FIFO") registers.

7. The device of claim 1, wherein the synchronization device comprises a generic array logic ("GAL") device.

8. The device of claim 1,

wherein each of the plurality of registers comprises a final bit position and the final bit position of each of the plurality of registers aligns with the final bit position of every other one of final bit positions, and

wherein a given input port that is coupled to a given register of the plurality of registers is configured register a sequence of statuses into the given register based on a sequence of statuses received at the input port coupled to the given register, and

wherein the given register is configured to shift the sequence of statuses through the given register based on the movement signal, and to provide a given status of the sequence of statuses at the final bit position of the given register when a product of the one or more products that has been assigned the given status has arrived at the predetermined location.

9. The device of claim 1, the product status synchronization device further comprising:

a plurality of windows, each of the plurality of windows separately and individually coupled to one of the plurality of registers,

wherein each of the windows is configured to group a plurality of last bits of the register coupled to that window, and to provide an output status based on a status provided by one or more of the plurality of last bits of the register grouped by the window coupled to the register.

10. The device of claim 1, wherein the registers are configured to be shifted based on the receipt of encoder pulses corresponding to a movement of the mechanism configured to move the one or more products through the processing line.

11. The device of claim 1, wherein the status of a product is a status assigned to the product as a result of an inspection performed on the product by a machine vision system.

12. The device of claim 1, wherein the product status synchronization device further comprises a product detect input and a product missing product detected output, the product detect input configured to receive an input signal indicative of the presence of a product at the predetermined location,

the product status synchronization device further configured to determine, based on the status provided by one or more of the plurality of registers, that a product should be present at the predetermined location, and to provide an output signal at the missing product detected output when a determination has been made that a product should be present at the predetermined location and the product detect input is not providing the input signal indicative of the presence of the product at the predetermined location.

13. The device of claim 1, the product status synchronization device further comprising:

a delay block comprising an additional register, the additional register configured to register a final status determined for a product arriving at the predetermined location,

wherein the product status synchronization device is configured to determine the final status for a product that has arrived at the predetermined location based on a status determined for the product based on a plurality of statuses assigned to the product and registered into the plurality of registers,

the delay block configured to shift the final status assigned to the product through the additional register based on the movement signal,

the additional register configured to have an additional register length that corresponds to a distance along the processing line between the predetermined location and a reject station located along the processing line,

the delay block further configured to provide the final status of the product as a status output signal when the product arrives at the reject station.

14. A method comprising:

receiving, at a product status synchronization device, a first signal indicative of a first status assigned to a product by a first process performed on the product at a first process station, the first process station located at a first distance from a predetermined location along a processing line;

registering the first status into a first register included in the product status synchronization device, the first register configured to have a first register length corresponding to the first distance and a having a first register last bit position;

receiving, at the product status synchronization device, at least one additional signal indicative of a second status assigned to the product by a second process performed on the product at a second process station, the second process station located at a second distance from a predetermined location along a processing line, and wherein the second distance is different from the first distance;

registering the second status into a second register included in the product status synchronization device, the second register configured to have a second register length corresponding to the second distance and a having a second register last bit position;

shifting the first status through the first register and shifting the second status through the second register based on a movement signal indicative of movement of the product through the processing line so that the first status is shifted into the first register last bit position and the second status is shifted into the second register last bit position when the product arrives at the predetermined location, wherein the first register and the second register are provided as a generic logic gate array (GAL) device; and

determining, by the product status synchronization device, a final status for the product based on the first status provided at the first register last bit position and the second status provided at the second register last bit position.

15. The method of claim 14, wherein at least one of the first process or the second process comprises an inspection process of the product, and wherein at least one of the first signal or the second signal includes an indication of a status for the product determined as a result of the inspection process.

16. The method of claim 14, further comprising:

receiving, at the product status synchronization device, a product detect signal indicating that the product is not being detected at the predetermined location;

determining, by the product status synchronization device and based on the movement signal indicative of movement of the product through the processing line, that the product should have arrived at the predetermined location;

generating, by the product status synchronization device, a missing product detected signal indicating that the product is not being detected at the predetermined location and should have arrived at the predetermined location; and

outputting, from the product status synchronization device, the missing product detected signal.

17. The method of claim 14, further comprising:

outputting, by the product status synchronization device, a status signal to a reject station located at the predetermined location, the status signal including an indication of the final status for the product located at the reject station.

18. A method comprising:

assigning a separate register of a plurality of registers provided within a product tracking status circuit to a given and different one of a plurality of process stations provided at different positions along a processing line;

moving a calibration product through the processing line, and generating a product present signal at each process station when the calibration product arrives at that process station;

receiving, at the product status synchronization device, each of the product present signals indicating that the calibration product has arrived at each of the process stations;

tracking, at the product status synchronization device, a number of encoder pulses associated with moving the calibration product from each of the plurality of process stations to a predetermined location along the processing line; and

for each of the separate registers, setting a register length for the separate register based on the number of encoder pulses associated with tracking the moving of the calibration product from the process station assigned to the separate register to the predetermined location.

19. The method of claim 18, further comprising:

aligning the separated registers so that a final bit of each of the plurality of registers corresponds with the arrival of the calibration product at the predetermined location.

20. A system comprising:

a processing line having a plurality of process stations positioned at one or more different locations along a processing line, the processing line configured to move one or more products through the processing line and to provide processing of the one more products at the plurality of process stations, each process station configured to provide an output signal indicative of a status assigned to a product of the one or more products processed by that process station; and

a product status synchronization device comprising a plurality of input ports and an encoder input, each of the input ports coupled to one of the plurality of process stations and to one of a plurality of registers, and configured to receive a signal indicative of the status assigned to a product process by the