TECHNICAL NOTES

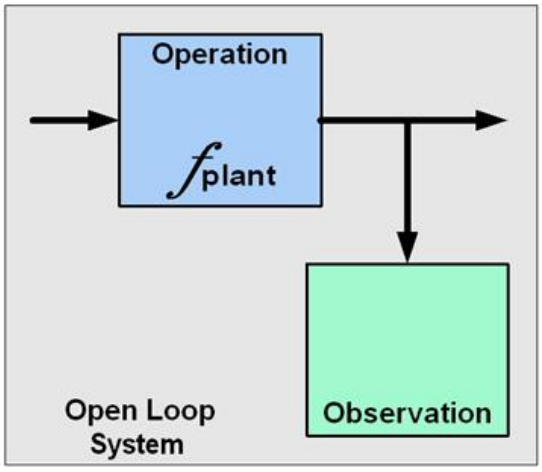
VASIT007

“Closed Loop” Systems

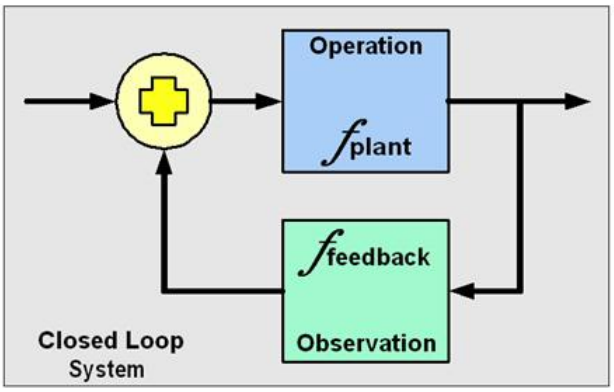
"Closed-Loop" systems are systems where output information is "fed back" into the input to compensate for variations in the system. Closed loop systems are contrasted to "open loop" systems that do not use feedback to alter operation. Although both closed loop systems and open loop systems have existed for many years, modern computing technology has allowed using closed loops in situations not previously possible. Closed loop systems originated out of "control systems" that required precision for proper operation. There are thousands of articles that describe and distinguish between closed loop and open loop systems. A great example of the difference between a closed loop and an open loop system is seen when comparing automatic and manual transmissions in automobiles. A manual transmission equipped automobile provides no feedback to "change gears" and relies on an external input to change speed or control engine RPM. In automatic transmission equipped automobiles, the transmission has a feedback mechanism that monitors engine speed and automatically compensates to control engine RPM, and thereby compensating for both terrain changes (going up a hill) and driver desired velocity input (the throttle or gas pedal).

It would be worthwhile to look at some of the articles on closed loop systems that are available on the Internet. Notice the distinctions made between the systems. A particularly interesting one that we found is: http://www.dbazine.com/datawarehouse/dw-articles/inmon12, an article entitled "Closed Loop Systems" written by Bill Inmon, who is universally recognized as the "father of the data warehouse."

The following two diagrams respectively represent open and closed loop systems. The "Operation" receives input (data) and from that makes a plan or generates an output that may then be observed (data may be collected) but no action is taken on that data. This is like sitting in your car, looking at the road ahead, determining the best gear to select for your manual transmission, and then hitting the gas. In distribution operations the only correction that may be undertaken is upon completion of the current operation.



The next diagram represents a closed loop system. In this situation, the observed results of the current operation are "fed back" to constantly modify the input to create the desired outcome. In this situation the system continuously adapts to changes encountered in the operation. In closed loop systems you may encounter the term "PID" which stands for "Proportional, Integral, and Differential". This term applies to the feedback function. The feedback function determines the amount and rate of adjustment necessary to create the desired outcome. You have encountered and witnessed the benefits of "PID" controlled closed loops many times. Again from automotive industry, speed or cruise controls on cars include PID feedback.



As the cruise control automatically controls the throttle (gas), the control is not only observing the current speed, it is also monitoring the rate of change of speed (differential velocity) and well as the average speed of the past several seconds (integral of the velocity). The "proportional" element is the difference between the current speed and the desired speed. By creating a feedback function using these values it is possible to detect slight changes in velocity that will create slight changes in the application of the throttle, that allow the cruise control to accurately control the velocity at the desire value and not "oscillate". A closed loop system can react to the slightest changes that a good human "observer" may not even detect, you can encounter a slight hill, a strong head or tail wind, pulling a trailer, a miss-firing sparkplug, high an low octane fuel, literally any unexpected event and the cruise control just keeps the proper set speed until such time the system is out of range of control.

So how do closed loop systems apply to logistical operations? Typically, or more correctly near universally, open loop techniques are used to control logistical operations. Plans are made and then executed. Feedback is limited to human observation sometimes aided by real-time progress reporting tools. Adjustment to the plan, if possible, is accomplished by supervision re-directing efforts. Distribution and fulfillment operations are nothing more than complex "plants" with complex and unexpected conditions continuously being encountered. Billy is ill and working slower than expected, you had a large order of very few SKUs that was unexpected, someone tipped over a pallet of bolts, today's order profile was not typical, and on and on. You know the obstacles that face distribution operations. Is it possible to operate in an "open loop fashion"? Certainly – you have been doing it for years. We also drove cars for years without automatic transmissions and speed controls. The real question is what is the benefit of using a closed loop design? Things that you need to consider are: improved productivity by lowered worker idle time, reduced supervision through automatic control of work flow, higher capacity through constant work flow, reduced facility hours through better productivity, and so on. We have installed closed loop systems that have created benefits that paid for the entire system in a matter of months.

VAS is the leader in "closed loop" implementations in the distribution and fulfillment operations arena. As "closed loop" technology moves into distribution and fulfillment operations, there are some that will claim that there is no distinction between open and closed loop system or that they are too complex, impossible to implement, too expensive, or simply that they already provide closed loop systems by claiming that a supervisor closes the loop. You be the judge. We have grown up in real-time dynamically optimized systems. We have made closed loop systems for years in hundreds of differing forms and applications both within and outside our industry.