

The art and science

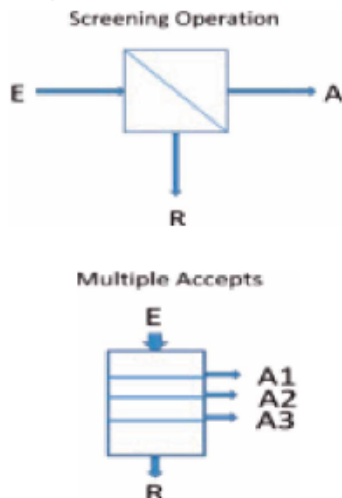
In the first of a two-part series, Gustavo L. Bottan of Passport Systems takes an in-depth look at the principles of cargo screening

The 100% cargo screening mandate by the United States Government has produced a lot of debate around the world. Regardless of its pros and cons, supporters and detractors, there seems to be confusion as to what it means. What is screening? Is it the same as inspection? Is it x-ray scanning or other technologies and methods? What are we inspecting for? What constitutes a good level of inspection? The number of questions is large, but in spite of all this confusion, the one thing that is certain is that there will be significant expenditures made in addressing the mandate.

In this article I will try to describe the general principles of screening, bringing to bear what screening is in industries that depend on it on a continuous basis. Then I will comment on these principles, applied to the supply chain and the transport of cargo containers, in the hope that some context can be provided to the reader related to the questions above.

Principles of screening

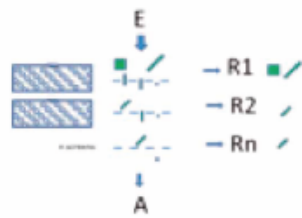
In a generic sense, screening as a unit operation is found everywhere. Sifting earth and rocks to separate them with a sieve is something we may do in our gardens. Papermaking processes remove impurities and undesirable specks and fibres from the good fibres that will go to make paper. A schematic is shown below.



There is always a material flow (E) entering the screening operation or device and two or more flows of material coming out, Accepts (A) and Rejects (R). Depending on the screening operation, there could be more than one flow of Accepts (think for example of various grades of rocks A1, A2, being separated by different perforation-size screens). The balance constitutes the Rejects flow where $R = E \text{ minus } A$.

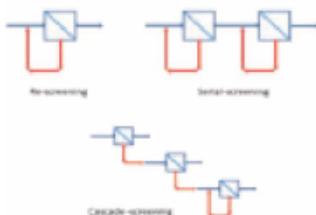
Things get more complex when you require screening (separation) along the lines of more than one parameter. If the incoming flow has materials of various sizes and shapes and we only want to accept small cubes, there will be long particles that could still make it though the perforated plates. By adding similar plates, the probability that the slender particles would be perfectly aligned to make it past the hole diminishes (see image below).

Screening for more than one parameter



All of the above screening scenarios did not contemplate recycling of flows. When screening is considered as a whole system, the only thing that matters is what comes into the system and what comes out. Therefore, any intermediate steps can be designed to maximise the likelihood of achieving the type of Accepts and Rejects required by the system as a whole. There are many configurations possible (see below).

Screening Systems



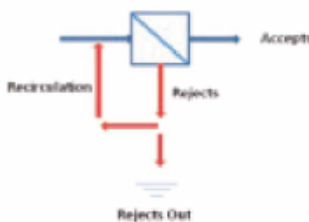
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of cargo screening

The simplest system with recycling of flows consists of one screening station where the Reject stream is re-screened. We experience this at the airport check-in when they take our carry-on for a second pass through the scanner. The configuration shown on page 30 is much simplified as it is obvious that some Rejects will have to eventually come out of the system rather than be sent back to the screen's inlet (see below). The more Rejects one removes from the system, the higher the Accept quality.

Accepts' quality is a function of Rejects out



A more involved system includes serial screening. It increases the quality of the Accepts because of the added probability of separating the undesirable materials. Perhaps the most common of screening systems is Cascade screening. A primary screening station of high efficiency will only let the 'good' material through to the Accepts side. In order to achieve this, it may have to send too much 'good' material together with the undesirable material into the Rejects stream.

Material flows

When considering more than one screening station, material flow design becomes equally important for the success of the overall system. Each screening station must be able to constantly receive and process materials without creating back-ups. In close-coupled systems, this is accomplished by feedback controls and intermediary buffering to handle the most common situations. There is no system completely immune to disruptions, so careful design must be considered to minimise them and allow for prompt resumption of operations after they occur.

Material Flows – Controls & Buffer



The image above is a significantly simplified graphic showing a 'level' control on each buffer 'tank'. Let's assume the secondary screening station (the middle one) cannot take the amount of incoming material. The level of its feeder tank will rise and signals will be sent to the appropriate screen station to slow down (i.e. reduce the inlet flow to the primary screen and/or increase the inlet flow to the tertiary screen). The design of these controls is completely dependent on the architecture of the system (i.e. whether it consists of a serial or cascade approach, whether the streams of Accepts and Rejects are coupled in an upstream or downstream fashion, etc).

We have not made much distinction on the screening efficiency and purpose of each screening unit in a system. In reality, depending on the requirements of the Accept flow quality, a system would be designed with basically the same type of screening unit in all stations (perhaps just varying the capacity), while in other systems there would be more than one type of screen properly placed in the architecture so the overall screening objective can be accomplished.

Container screening operations

There are significant differences between the screening performed in industrial processes like those referred to above and that of screening cargo containers at a port. The goal in industry usually has direct economic impact, i.e. the product quality (Accept flow) is improved or the sorting between materials (classification) provides pricing differentiation of value to the producer. By contrast, screening of cargo containers at a

port has never been envisioned as a means to determine the quality or safety of the products in the container or to provide a mechanism for sorting cargo. Ports depend on fast material movement in and out and therefore screening is generally considered only a requirement by Customs authorities and a reduction in productivity and the flow of containers. There are also space constraints in a port, so added operations like screening would take precious space not so much by the screening equipment itself but by the traffic lanes and waiting areas for the cargo to await inspection.

In spite of these facts, there are ways to promote the flow of containers and provide added economic value to the supply chain. To achieve this, the screening objectives must be clearly understood and a system approach used, i.e. not just one screening station in isolation, but several properly configured and linked, thereby ensuring that everything coming into a port is inspected and assessed before clearing it for delivery. This will require, however, some adaptations of current supply chain business models including those of ports, where not just expediency and volume would be the only drivers. In the end, there would be advantages gained by the reduction of losses due to theft and crime, reduction in leakages, knowledge that the goods delivered are safe, and a robust and resilient operation.

Just as we find little resemblance between the airports of today and those in the 1950s, sea cargo container ports will evolve. This will not be an easy task, but many ports and supply chain parties have already embarked on this quest. They are looking for solutions and improvement in their operations in the hopes of not just complying with security mandates, but strengthening their business profitability and sustainability.

Part II of this series, will cover more specifically what a screening operation may be like at a port and how it may contribute to achieving the goals enumerated above.