14 Mutual influence of $B$ and $Q$

14.1 Principle

It is possible to calculate both the re-order level ($B$) and the size of the series ($Q$) separately. The $B$ and $Q$ so found are not optimal, but are a good approximation to the optimum solution.

Characteristic of the re-order level is the direct connexion between the risk of running out of stock ($z$) and the height of the order level. As $B$ becomes higher (and therefore $b$, the safety stock, is increased), $z$ becomes smaller. This relationship is determined by the cumulative frequency distribution of the demand during the delivery time.

With a high order level, a rather considerable stock will, in general, still be present upon the arrival of the replenishment order; thus the relevant stock costs are consequently high.

The connexion between these quantities is illustrated in Fig. 53. Since all costs must relate to a definite time unit it is not sufficient to know the value of $z$, but also the frequency with which a replenishment order is received (= the number of orders p.a.) must be known.

![Figure 53: The relationship of $B$ to $z$ and $B$ to $b$.](image)

The costs of running out of stock p.a. per product are therefore

$$R \frac{D}{Q} z$$
The stock costs of the safety stock are equal to $b.c_i$; the change-over costs are $(D/Q)F$ (all per time unit, in this case p.a.)

$$C_{tot} = z(D/Q)R + F(D/Q) + \frac{1}{2}c_i Q + c_i b$$

It appears from further examination of this equation that both $b$ and $Q$ affect the total costs which play a part in the system.

Moreover, by increasing $Q$ and decreasing $b$ (or the reverse) $c_{tot}$ can remain constant if an optimum system has still to be attained. A further study has shown what the relationship is between $B$ and $Q$ for constant total costs.

14.2 The relationship between $B$ and $Q$

It is possible to obtain, with the assistance of the equation mentioned above, a quantitative insight into the relationship between $B$ and $Q$. A clear picture is obtained if this result is presented graphically. It is, however, necessary to make a three-dimensional drawing because it has already been shown that $C_{tot}$ is simultaneously dependent upon $B$ and $Q$.

It can be calculated for any single case just how large $C_{tot}$ is at certain values of $B$ and $Q$. It is not possible to give a clear picture of this in two dimensions, however, and, therefore, some horizontal cross sections will be taken.

Fig. 54. The iso-cost lines for a $(B, Q)$-system.

$A$ = The point with the lowest total variable costs ($c^*_{tot}$).

The line of intersection formed by the cost plane and a horizontal plane is a line with equal total costs (iso-cost line). The lowest total costs are found at point $A$; the optimum size of the replenishment batch and the order level can