Simplification of a Context-free Grammar (certain definitions)

Let G= (N, ∑, R, S) be a CFG.

A symbol X in N U ∑ is called generating if X -->* w for some w in ∑*.

A symbol X in N U ∑ is called reachable if S →* α X β for some α, β in (N U ∑)*.

Generating and reachable symbols are called useful and other symbols are called useless.

A production of the form A -> ϵ is called an epsilon-production.

A production of the form A -> B is called an unit production.

A CFG is called simple if it has no epsilon-production, no unit production and no useless symbols.

Given a CFG G we can simplify it ie we can obtain a simple grammar G' such that L(G') = L(G) – {ϵ}.

For simplification the following three steps have to be carried out in that order.

1) Elimination of epsilon productions.
2) Elimination of unit productions.
3) Elimination of useless symbols.