We propose to define a new programming connective $P \, \, \# \, \, Q$. What properties of $\#$ are essential? Why?

After trying the question, scroll down to the solution.
§ It must be defined for all specifications $P$ and $Q$, not just for programs, so that it can be used during program development. It must be implementable, which means

\[(\forall \sigma \exists \sigma' \cdot P \land t' \geq t) \land (\forall \sigma \exists \sigma' \cdot Q \land t' \geq t) \Rightarrow (\forall \sigma \exists \sigma' \cdot (P \bowtie Q) \land t' \geq t)\]

(This property can be contested because ensure is not implementable.) It must be monotonic in both operands so that Refinement by Steps and Refinement by Parts can be used.

If $A \iff B \bowtie C$ and $B \iff D$ and $C \iff E$ are theorems,

then $A \iff D \bowtie E$ is a theorem.

If $A \iff B \bowtie C$ and $D \iff E \bowtie F$ are theorems,

then $A \land D \iff B \land E \bowtie C \land F$ is a theorem.

(Since $\bowtie$ is a symmetric symbol, perhaps it ought to be a symmetric operator $P \bowtie Q = Q \bowtie P$

but that's not an essential point and there are lots of counterexamples.)