Problem – D (Assembly)

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/*********************************************
 * OPL 12.6.0.0 Model
 * Author: Hakeem-ur-Rehman
 * Creation Date: Apr 14, 2017 at 11:09:27 AM
 *********************************************/
// Converting IP/MIP to LP
//main{
//thisOplModel.convertAllIntVars();
//thisOplModel.generate();
//cplex.solve();
//
//writeln("Relaxed Model");
//writeln("OBJECTIVE: ",cplex.getBestObjValue());
//}

//execute PARAMS {
//    //cplex.tilim = 3600; // stops and returns the current solution after 3600 seconds
//    //cplex.threads = 2; // Number of threads
//}

//main{
// thisOplModel.generate();
// if(cplex.solve()){
//  writeln("Solve successful; solve status="+cplex.getCplexStatus());
//  writeln("Objective value="+cplex.getObjValue());
// }
// else{
//  writeln("Solve failed; CPLEX status="+cplex.getCplexStatus());
//  writeln("Calling printConflict (CONFLICT REFINER)");
//  writeln(thisOplModel.printConflict());
//  writeln("Printing conflicts using conflictIterator");
//  var confIter = thisOplModel.conflictIterator;
//  for(var x in confIter){
//   writeln("Member name:"+x.ct.name);
//   writeln("Conflict type:"+x.info);
//  }
//  writeln("Calling printRelaxation (FEASOPT)");
//  writeln(thisOplModel.printRelaxation());
//  writeln("Printing relaxations using relaxationIterator");
//  var relaxIter = thisOplModel.relaxationIterator;
//  for(x in relaxIter){
//   writeln("Member name:"+x.ct.name);
//   writeln("Old bound:"+x.info);
//   writeln("New bound:"+x.info2);
//   writeln("Bound changed to:"+x.info3);
//  }
// }
//}


// Define and Initialize INDICES & PARAMETERS DATA
   int FP=...;          range Final_Products=1..FP;
   int RP=...;          range Remaining_Products=7..RP;
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```
   int J=...;          range products=1..J;               // Represents All the
products
   int L=...;          range productionstages=1..L;
   int S=...;          range microperiods=1..S;
   int T=...;          range macroperiods=1..T;

// Define & Initialize Sets
      {int} allproductsonstage1 = ...; // All products at Stage One
      {int} allproductsonstage2 = ...;
      {int} allproductsonstage3 = ...;
      {int} allproductsonstage4 = ...;
      {int} allproductsonstage5_1 = ...;
      {int} allproductsonstage5_2 = ...;
      {int} family1stage1 = ...;          // Family-1 who has same successor in the
following stage
      {int} family2stage1 = ...;
      {int} family3stage1 = ...;
      {int} family4stage1 = ...;
      {int} family5stage1 = ...;
      {int} family6stage1 = ...;
      {int} family7stage1 = ...;
      {int} family8stage1 = ...;
      {int} family9stage1 = ...;
      {int} family1stage2 = ...;
      {int} family2stage2 = ...;
      {int} family3stage2 = ...;
      {int} family4stage2 = ...;
      {int} family5stage2 = ...;
      {int} family6stage2 = ...;
      {int} family7stage2 = ...;
      {int} family8stage2 = ...;
      {int} family9stage2 = ...;
      {int} family10stage2 = ...;
      {int} family11stage2 = ...;
      {int} family12stage2 = ...;
      {int} family1stage3 = ...;
      {int} family2stage3 = ...;
      {int} family3stage3 = ...;
      {int} family4stage3 = ...;
      {int} family5stage3 = ...;
      {int} family6stage3 = ...;
      {int} family7stage3 = ...;
      {int} family8stage3 = ...;
      {int} family9stage3 = ...;
      {int} family10stage3 = ...;
      {int} family11stage3 = ...;
      {int} family12stage3 = ...;
      {int} family1stage4 = ...;
      {int} family2stage4 = ...;
      {int} family3stage4 = ...;
      {int} family4stage4 = ...;
      {int} family5stage4 = ...;
      {int} family6stage4 = ...;
      {int} family1stage5_1 = ...;
      {int} family1stage5_2 = ...;
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      {int} family2stage5_2 = ...;

      {int} microperiods1tomacroperiod = ...;
      {int} microperiods2tomacroperiod = ...;
      {int} microperiods3tomacroperiod = ...;
      {int} microperiods4tomacroperiod = ...;
      {int} microperiods5tomacroperiod = ...;
      {int} microperiods6tomacroperiod = ...;
      {int} microperiods7tomacroperiod = ...;
      {int} microperiods8tomacroperiod = ...;
      {int} microperiods9tomacroperiod = ...;
      {int} microperiods10tomacroperiod = ...;
      {int} microperiods11tomacroperiod = ...;
      {int} microperiods12tomacroperiod = ...;
      {int} microperiods13tomacroperiod = ...;
      {int} microperiods14tomacroperiod = ...;
      {int} microperiods15tomacroperiod = ...;
      {int} microperiods16tomacroperiod = ...;

// Declare & Initialize CONSTANT DATA
   // Initial Inventory of all the products
         //int initial_inv=...;
   // Maximum inventory level of the jth product
         //int max_inv=...;
   // Minimum Lotsize of the jth product
         int min_lotsize=...;
   // Production cost per unit
         int production_cost=...;
   // production time per unit
         int production_time=...;
   // Idle time (i.e. Stand by) cost
         int standby_cost=...;
   /* Pijl --> Number of units of product 'i' required to produce
      one unit of product 'j' on production stage 'l'*/
         int BOM = ...;
         int BigM = ...;

// Arrays Delcarations through indicies
   // Capacity of the Production Stages
         float productstagecapacity[productionstages]=...;
   // Product Holding Cost
         int holdingcost[products]=...;
   // Products Changeover Cost
         float setupcost[products]=...;
   // Products Changeover Time
         int setuptime[products]=...;
   // Products Demand
         float primary_demand[Final_Products][macroperiods]=...;
         float secondary_demand[Remaining_Products][macroperiods]=...;

// Defining Decision Variables
      // Inventory Level of jth Product on Lth production stage in Tth macroperiod
         dvar float+ inventory[products][0..T];
      // Total Production Quality of the products on machines'm' in 't'
         dvar float+ productionquantity[products][productionstages][microperiods];
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      // Product Changeover in Microperiod 's'
            dvar float+ Pchangeover[products][products][productionstages][microperiods];
      // Fractional setup time for changeover at the begining of microperiod 's'
            dvar float+ B_setuptime[productionstages][microperiods];
      // Fractional setup time for changeover at the end of microperiod 's'
            dvar float+ E_setuptime[productionstages][microperiods];
      // Standby (idle) time on machine 'l' in microperiod 's'
            dvar float+ sb[productionstages][microperiods];
            //dvar float+ sb[allproductstage][micro_macroperiods];
      // Lth Machine setup for jth Product in sth Microperiod
            dvar boolean stagesetup[products][productionstages][0..S];

// Computing the objective function value
      dexpr float TotalProductionCost = sum(j in products, l in productionstages, s in
microperiods)

      production_cost*productionquantity[j][l][s];
      dexpr float TotalHoldingCost = sum(j in products, t in macroperiods)

      holdingcost[j]*inventory[j][t];
      dexpr float TotalSetupCost = sum(i,j in products, l in productionstages, s in
microperiods)

      setupcost[j]*Pchangeover[i][j][l][s];
      dexpr float TotalStandbyCost = sum(l in productionstages, s in microperiods)

      standby_cost*sb[l][s];
      // Total Value of the Objective Function
      dexpr float TOTAL_COST = TotalProductionCost + TotalHoldingCost + TotalSetupCost +
TotalStandbyCost;

// The Model
minimize TOTAL_COST;
subject to
      {
      // Inventory Balancing constraints for final_products on final_stage
      forall (j in Final_Products, l in productionstages:l==L, t in macroperiods)
       Inventory_Balancing: {
       if(t==1)
            inventory[j][t-1] + sum(s in microperiods1tomacroperiod)
productionquantity[j][l][s]
            == inventory[j][t] + primary_demand[j][t];
       if(t==2)
            inventory[j][t-1] + sum(s in microperiods2tomacroperiod)
productionquantity[j][l][s]
            == inventory[j][t] + primary_demand[j][t];
       if(t==3)
            inventory[j][t-1] + sum(s in microperiods3tomacroperiod)
productionquantity[j][l][s]
            == inventory[j][t] + primary_demand[j][t];
       if(t==4)
            inventory[j][t-1] + sum(s in microperiods4tomacroperiod)
productionquantity[j][l][s]
            == inventory[j][t] + primary_demand[j][t];
       if(t==5)
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            inventory[j][t-1] + sum(s in microperiods5tomacroperiod)
productionquantity[j][l][s]
            == inventory[j][t] + primary_demand[j][t];
       if(t==6)
            inventory[j][t-1] + sum(s in microperiods6tomacroperiod)
productionquantity[j][l][s]
            == inventory[j][t] + primary_demand[j][t];
       if(t==7)
            inventory[j][t-1] + sum(s in microperiods7tomacroperiod)
productionquantity[j][l][s]
            == inventory[j][t] + primary_demand[j][t];
       if(t==8)
            inventory[j][t-1] + sum(s in microperiods8tomacroperiod)
productionquantity[j][l][s]
            == inventory[j][t] + primary_demand[j][t];
       if(t==9)
            inventory[j][t-1] + sum(s in microperiods9tomacroperiod)
productionquantity[j][l][s]
            == inventory[j][t] + primary_demand[j][t];
       if(t==10)
            inventory[j][t-1] + sum(s in microperiods10tomacroperiod)
productionquantity[j][l][s]
            == inventory[j][t] + primary_demand[j][t];
       if(t==11)
            inventory[j][t-1] + sum(s in microperiods11tomacroperiod)
productionquantity[j][l][s]
            == inventory[j][t] + primary_demand[j][t];
       if(t==12)
            inventory[j][t-1] + sum(s in microperiods12tomacroperiod)
productionquantity[j][l][s]
            == inventory[j][t] + primary_demand[j][t];
       if(t==13)
            inventory[j][t-1] + sum(s in microperiods13tomacroperiod)
productionquantity[j][l][s]
            == inventory[j][t] + primary_demand[j][t];
       if(t==14)
            inventory[j][t-1] + sum(s in microperiods14tomacroperiod)
productionquantity[j][l][s]
            == inventory[j][t] + primary_demand[j][t];
       if(t==15)
            inventory[j][t-1] + sum(s in microperiods15tomacroperiod)
productionquantity[j][l][s]
            == inventory[j][t] + primary_demand[j][t];
       if(t==16)
            inventory[j][t-1] + sum(s in microperiods16tomacroperiod)
productionquantity[j][l][s]
            == inventory[j][t] + primary_demand[j][t];

       }

       // WIP Balancing constraints
      forall (j in allproductsonstage1, l in productionstages:l==1, t in macroperiods)
       WIPInventory_Balancing1: {
       if(t==1)
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            inventory[j][t-1] + sum(s in microperiods1tomacroperiod)
productionquantity[j][l][s]
            == inventory[j][t] + BOM * secondary_demand[j][t];
       if(t==2)
            inventory[j][t-1] + sum(s in microperiods2tomacroperiod)
productionquantity[j][l][s]
            == inventory[j][t] + BOM * secondary_demand[j][t];
       if(t==3)
            inventory[j][t-1] + sum(s in microperiods3tomacroperiod)
productionquantity[j][l][s]
            == inventory[j][t] + BOM * secondary_demand[j][t];
       if(t==4)
            inventory[j][t-1] + sum(s in microperiods4tomacroperiod)
productionquantity[j][l][s]
            == inventory[j][t] + BOM * secondary_demand[j][t];
       if(t==5)
            inventory[j][t-1] + sum(s in microperiods5tomacroperiod)
productionquantity[j][l][s]
            == inventory[j][t] + BOM * secondary_demand[j][t];
       if(t==6)
            inventory[j][t-1] + sum(s in microperiods6tomacroperiod)
productionquantity[j][l][s]
            == inventory[j][t] + BOM * secondary_demand[j][t];
       if(t==7)
            inventory[j][t-1] + sum(s in microperiods7tomacroperiod)
productionquantity[j][l][s]
            == inventory[j][t] + BOM * secondary_demand[j][t];
       if(t==8)
            inventory[j][t-1] + sum(s in microperiods8tomacroperiod)
productionquantity[j][l][s]
            == inventory[j][t] + BOM * secondary_demand[j][t];
       if(t==9)
            inventory[j][t-1] + sum(s in microperiods9tomacroperiod)
productionquantity[j][l][s]
            == inventory[j][t] + BOM * secondary_demand[j][t];
       if(t==10)
            inventory[j][t-1] + sum(s in microperiods10tomacroperiod)
productionquantity[j][l][s]
            == inventory[j][t] + BOM * secondary_demand[j][t];
       if(t==11)
            inventory[j][t-1] + sum(s in microperiods11tomacroperiod)
productionquantity[j][l][s]
            == inventory[j][t] + BOM * secondary_demand[j][t];
       if(t==12)
            inventory[j][t-1] + sum(s in microperiods12tomacroperiod)
productionquantity[j][l][s]
            == inventory[j][t] + BOM * secondary_demand[j][t];
       if(t==13)
            inventory[j][t-1] + sum(s in microperiods13tomacroperiod)
productionquantity[j][l][s]
            == inventory[j][t] + BOM * secondary_demand[j][t];
       if(t==14)
            inventory[j][t-1] + sum(s in microperiods14tomacroperiod)
productionquantity[j][l][s]
            == inventory[j][t] + BOM * secondary_demand[j][t];
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       if(t==15)
            inventory[j][t-1] + sum(s in microperiods15tomacroperiod)
productionquantity[j][l][s]
            == inventory[j][t] + BOM * secondary_demand[j][t];
       if(t==16)
            inventory[j][t-1] + sum(s in microperiods16tomacroperiod)
productionquantity[j][l][s]
            == inventory[j][t] + BOM * secondary_demand[j][t];

       }
       forall (j in allproductsonstage2, l in productionstages:l==2, t in macroperiods)
       WIPInventory_Balancing2: {
       if(t==1)
            inventory[j][t-1] + sum(s in microperiods1tomacroperiod)
productionquantity[j][l][s]
            == inventory[j][t] + BOM * secondary_demand[j][t];
       if(t==2)
            inventory[j][t-1] + sum(s in microperiods2tomacroperiod)
productionquantity[j][l][s]
            == inventory[j][t] + BOM * secondary_demand[j][t];
       if(t==3)
            inventory[j][t-1] + sum(s in microperiods3tomacroperiod)
productionquantity[j][l][s]
            == inventory[j][t] + BOM * secondary_demand[j][t];
       if(t==4)
            inventory[j][t-1] + sum(s in microperiods4tomacroperiod)
productionquantity[j][l][s]
            == inventory[j][t] + BOM * secondary_demand[j][t];
       if(t==5)
            inventory[j][t-1] + sum(s in microperiods5tomacroperiod)
productionquantity[j][l][s]
            == inventory[j][t] + BOM * secondary_demand[j][t];
       if(t==6)
            inventory[j][t-1] + sum(s in microperiods6tomacroperiod)
productionquantity[j][l][s]
            == inventory[j][t] + BOM * secondary_demand[j][t];
       if(t==7)
            inventory[j][t-1] + sum(s in microperiods7tomacroperiod)
productionquantity[j][l][s]
            == inventory[j][t] + BOM * secondary_demand[j][t];
       if(t==8)
            inventory[j][t-1] + sum(s in microperiods8tomacroperiod)
productionquantity[j][l][s]
            == inventory[j][t] + BOM * secondary_demand[j][t];
       if(t==9)
            inventory[j][t-1] + sum(s in microperiods9tomacroperiod)
productionquantity[j][l][s]
            == inventory[j][t] + BOM * secondary_demand[j][t];
       if(t==10)
            inventory[j][t-1] + sum(s in microperiods10tomacroperiod)
productionquantity[j][l][s]
            == inventory[j][t] + BOM * secondary_demand[j][t];
       if(t==11)
            inventory[j][t-1] + sum(s in microperiods11tomacroperiod)
productionquantity[j][l][s]
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            == inventory[j][t] + BOM * secondary_demand[j][t];
       if(t==12)
            inventory[j][t-1] + sum(s in microperiods12tomacroperiod)
productionquantity[j][l][s]
            == inventory[j][t] + BOM * secondary_demand[j][t];
       if(t==13)
            inventory[j][t-1] + sum(s in microperiods13tomacroperiod)
productionquantity[j][l][s]
            == inventory[j][t] + BOM * secondary_demand[j][t];
       if(t==14)
            inventory[j][t-1] + sum(s in microperiods14tomacroperiod)
productionquantity[j][l][s]
            == inventory[j][t] + BOM * secondary_demand[j][t];
       if(t==15)
            inventory[j][t-1] + sum(s in microperiods15tomacroperiod)
productionquantity[j][l][s]
            == inventory[j][t] + BOM * secondary_demand[j][t];
       if(t==16)
            inventory[j][t-1] + sum(s in microperiods16tomacroperiod)
productionquantity[j][l][s]
            == inventory[j][t] + BOM * secondary_demand[j][t];
            }
      forall (j in allproductsonstage3, l in productionstages:l==3, t in macroperiods)
       WIPInventory_Balancing3: {
       if(t==1)
            inventory[j][t-1] + sum(s in microperiods1tomacroperiod)
productionquantity[j][l][s]
            == inventory[j][t] + BOM * secondary_demand[j][t];
       if(t==2)
            inventory[j][t-1] + sum(s in microperiods2tomacroperiod)
productionquantity[j][l][s]
            == inventory[j][t] + BOM * secondary_demand[j][t];
       if(t==3)
            inventory[j][t-1] + sum(s in microperiods3tomacroperiod)
productionquantity[j][l][s]
            == inventory[j][t] + BOM * secondary_demand[j][t];
       if(t==4)
            inventory[j][t-1] + sum(s in microperiods4tomacroperiod)
productionquantity[j][l][s]
            == inventory[j][t] + BOM * secondary_demand[j][t];
       if(t==5)
            inventory[j][t-1] + sum(s in microperiods5tomacroperiod)
productionquantity[j][l][s]
            == inventory[j][t] + BOM * secondary_demand[j][t];
       if(t==6)
            inventory[j][t-1] + sum(s in microperiods6tomacroperiod)
productionquantity[j][l][s]
            == inventory[j][t] + BOM * secondary_demand[j][t];
       if(t==7)
            inventory[j][t-1] + sum(s in microperiods7tomacroperiod)
productionquantity[j][l][s]
            == inventory[j][t] + BOM * secondary_demand[j][t];
       if(t==8)
            inventory[j][t-1] + sum(s in microperiods8tomacroperiod)
productionquantity[j][l][s]
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            == inventory[j][t] + BOM * secondary_demand[j][t];
       if(t==9)
            inventory[j][t-1] + sum(s in microperiods9tomacroperiod)
productionquantity[j][l][s]
            == inventory[j][t] + BOM * secondary_demand[j][t];
       if(t==10)
            inventory[j][t-1] + sum(s in microperiods10tomacroperiod)
productionquantity[j][l][s]
            == inventory[j][t] + BOM * secondary_demand[j][t];
       if(t==11)
            inventory[j][t-1] + sum(s in microperiods11tomacroperiod)
productionquantity[j][l][s]
            == inventory[j][t] + BOM * secondary_demand[j][t];
       if(t==12)
            inventory[j][t-1] + sum(s in microperiods12tomacroperiod)
productionquantity[j][l][s]
            == inventory[j][t] + BOM * secondary_demand[j][t];
       if(t==13)
            inventory[j][t-1] + sum(s in microperiods13tomacroperiod)
productionquantity[j][l][s]
            == inventory[j][t] + BOM * secondary_demand[j][t];
       if(t==14)
            inventory[j][t-1] + sum(s in microperiods14tomacroperiod)
productionquantity[j][l][s]
            == inventory[j][t] + BOM * secondary_demand[j][t];
       if(t==15)
            inventory[j][t-1] + sum(s in microperiods15tomacroperiod)
productionquantity[j][l][s]
            == inventory[j][t] + BOM * secondary_demand[j][t];
       if(t==16)
            inventory[j][t-1] + sum(s in microperiods16tomacroperiod)
productionquantity[j][l][s]
            == inventory[j][t] + BOM * secondary_demand[j][t];
 }
 forall (j in allproductsonstage4, l in productionstages:l==4, t in macroperiods)
       WIPInventory_Balancing4: {
       if(t==1)
            inventory[j][t-1] + sum(s in microperiods1tomacroperiod)
productionquantity[j][l][s]
            == inventory[j][t] + BOM * secondary_demand[j][t];
       if(t==2)
            inventory[j][t-1] + sum(s in microperiods2tomacroperiod)
productionquantity[j][l][s]
            == inventory[j][t] + BOM * secondary_demand[j][t];
       if(t==3)
            inventory[j][t-1] + sum(s in microperiods3tomacroperiod)
productionquantity[j][l][s]
            == inventory[j][t] + BOM * secondary_demand[j][t];
       if(t==4)
            inventory[j][t-1] + sum(s in microperiods4tomacroperiod)
productionquantity[j][l][s]
            == inventory[j][t] + BOM * secondary_demand[j][t];
       if(t==5)
            inventory[j][t-1] + sum(s in microperiods5tomacroperiod)
productionquantity[j][l][s]
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            == inventory[j][t] + BOM * secondary_demand[j][t];
       if(t==6)
            inventory[j][t-1] + sum(s in microperiods6tomacroperiod)
productionquantity[j][l][s]
            == inventory[j][t] + BOM * secondary_demand[j][t];
       if(t==7)
            inventory[j][t-1] + sum(s in microperiods7tomacroperiod)
productionquantity[j][l][s]
            == inventory[j][t] + BOM * secondary_demand[j][t];
       if(t==8)
            inventory[j][t-1] + sum(s in microperiods8tomacroperiod)
productionquantity[j][l][s]
            == inventory[j][t] + BOM * secondary_demand[j][t];
       if(t==9)
            inventory[j][t-1] + sum(s in microperiods9tomacroperiod)
productionquantity[j][l][s]
            == inventory[j][t] + BOM * secondary_demand[j][t];
       if(t==10)
            inventory[j][t-1] + sum(s in microperiods10tomacroperiod)
productionquantity[j][l][s]
            == inventory[j][t] + BOM * secondary_demand[j][t];
       if(t==11)
            inventory[j][t-1] + sum(s in microperiods11tomacroperiod)
productionquantity[j][l][s]
            == inventory[j][t] + BOM * secondary_demand[j][t];
       if(t==12)
            inventory[j][t-1] + sum(s in microperiods12tomacroperiod)
productionquantity[j][l][s]
            == inventory[j][t] + BOM * secondary_demand[j][t];
       if(t==13)
            inventory[j][t-1] + sum(s in microperiods13tomacroperiod)
productionquantity[j][l][s]
            == inventory[j][t] + BOM * secondary_demand[j][t];
       if(t==14)
            inventory[j][t-1] + sum(s in microperiods14tomacroperiod)
productionquantity[j][l][s]
            == inventory[j][t] + BOM * secondary_demand[j][t];
       if(t==15)
            inventory[j][t-1] + sum(s in microperiods15tomacroperiod)
productionquantity[j][l][s]
            == inventory[j][t] + BOM * secondary_demand[j][t];
       if(t==16)
            inventory[j][t-1] + sum(s in microperiods16tomacroperiod)
productionquantity[j][l][s]
            == inventory[j][t] + BOM * secondary_demand[j][t];
 }
      //Capacity Constraints
         forall (l in productionstages, t in macroperiods)
          Capacity_Stage: {
           if(l==1 && t==1)
            sum(j in allproductsonstage1, s in microperiods1tomacroperiod)
production_time*
            productionquantity[j][l][s] + sum(i,j in allproductsonstage1, s in
microperiods1tomacroperiod)
```

```
            setuptime[j]*Pchangeover[i][j][l][s] + sum(s in microperiods1tomacroperiod)
sb[l][s] <= productstagecapacity[l];
           if(l==1 && t==2)
            sum(j in allproductsonstage1, s in microperiods2tomacroperiod)
production_time*
            productionquantity[j][l][s] + sum(i,j in allproductsonstage1, s in
microperiods2tomacroperiod)
            setuptime[j]*Pchangeover[i][j][l][s] + sum(s in microperiods2tomacroperiod)
sb[l][s] <= productstagecapacity[l];
           if(l==1 && t==3)
            sum(j in allproductsonstage1, s in microperiods3tomacroperiod)
production_time*
            productionquantity[j][l][s] + sum(i,j in allproductsonstage1, s in
microperiods3tomacroperiod)
            setuptime[j]*Pchangeover[i][j][l][s] + sum(s in microperiods3tomacroperiod)
sb[l][s] <= productstagecapacity[l];
           if(l==1 && t==4)
            sum(j in allproductsonstage1, s in microperiods4tomacroperiod)
production_time*
            productionquantity[j][l][s] + sum(i,j in allproductsonstage1, s in
microperiods4tomacroperiod)
            setuptime[j]*Pchangeover[i][j][l][s] + sum(s in microperiods4tomacroperiod)
sb[l][s] <= productstagecapacity[l];
           if(l==1 && t==5)
            sum(j in allproductsonstage1, s in microperiods5tomacroperiod)
production_time*
            productionquantity[j][l][s] + sum(i,j in allproductsonstage1, s in
microperiods5tomacroperiod)
            setuptime[j]*Pchangeover[i][j][l][s] + sum(s in microperiods5tomacroperiod)
sb[l][s] <= productstagecapacity[l];
           if(l==1 && t==6)
            sum(j in allproductsonstage1, s in microperiods6tomacroperiod)
production_time*
            productionquantity[j][l][s] + sum(i,j in allproductsonstage1, s in
microperiods6tomacroperiod)
            setuptime[j]*Pchangeover[i][j][l][s] + sum(s in microperiods6tomacroperiod)
sb[l][s] <= productstagecapacity[l];
           if(l==1 && t==7)
            sum(j in allproductsonstage1, s in microperiods7tomacroperiod)
production_time*
            productionquantity[j][l][s] + sum(i,j in allproductsonstage1, s in
microperiods7tomacroperiod)
            setuptime[j]*Pchangeover[i][j][l][s] + sum(s in microperiods7tomacroperiod)
sb[l][s] <= productstagecapacity[l];
           if(l==1 && t==8)
            sum(j in allproductsonstage1, s in microperiods8tomacroperiod)
production_time*
            productionquantity[j][l][s] + sum(i,j in allproductsonstage1, s in
microperiods8tomacroperiod)
            setuptime[j]*Pchangeover[i][j][l][s] + sum(s in microperiods8tomacroperiod)
sb[l][s] <= productstagecapacity[l];
           if(l==1 && t==9)
            sum(j in allproductsonstage1, s in microperiods9tomacroperiod)
production_time*
```

```
            productionquantity[j][l][s] + sum(i,j in allproductsonstage1, s in
microperiods9tomacroperiod)
            setuptime[j]*Pchangeover[i][j][l][s] + sum(s in microperiods9tomacroperiod)
sb[l][s] <= productstagecapacity[l];
           if(l==1 && t==10)
            sum(j in allproductsonstage1, s in microperiods10tomacroperiod)
production_time*
            productionquantity[j][l][s] + sum(i,j in allproductsonstage1, s in
microperiods10tomacroperiod)
            setuptime[j]*Pchangeover[i][j][l][s] + sum(s in microperiods10tomacroperiod)
sb[l][s] <= productstagecapacity[l];
           if(l==1 && t==11)
            sum(j in allproductsonstage1, s in microperiods11tomacroperiod)
production_time*
            productionquantity[j][l][s] + sum(i,j in allproductsonstage1, s in
microperiods11tomacroperiod)
            setuptime[j]*Pchangeover[i][j][l][s] + sum(s in microperiods11tomacroperiod)
sb[l][s] <= productstagecapacity[l];
           if(l==1 && t==12)
            sum(j in allproductsonstage1, s in microperiods12tomacroperiod)
production_time*
            productionquantity[j][l][s] + sum(i,j in allproductsonstage1, s in
microperiods12tomacroperiod)
            setuptime[j]*Pchangeover[i][j][l][s] + sum(s in microperiods12tomacroperiod)
sb[l][s] <= productstagecapacity[l];
           if(l==1 && t==13)
            sum(j in allproductsonstage1, s in microperiods13tomacroperiod)
production_time*
            productionquantity[j][l][s] + sum(i,j in allproductsonstage1, s in
microperiods13tomacroperiod)
            setuptime[j]*Pchangeover[i][j][l][s] + sum(s in microperiods13tomacroperiod)
sb[l][s] <= productstagecapacity[l];
           if(l==1 && t==14)
            sum(j in allproductsonstage1, s in microperiods14tomacroperiod)
production_time*
            productionquantity[j][l][s] + sum(i,j in allproductsonstage1, s in
microperiods14tomacroperiod)
            setuptime[j]*Pchangeover[i][j][l][s] + sum(s in microperiods14tomacroperiod)
sb[l][s] <= productstagecapacity[l];
           if(l==1 && t==15)
            sum(j in allproductsonstage1, s in microperiods15tomacroperiod)
production_time*
            productionquantity[j][l][s] + sum(i,j in allproductsonstage1, s in
microperiods15tomacroperiod)
            setuptime[j]*Pchangeover[i][j][l][s] + sum(s in microperiods15tomacroperiod)
sb[l][s] <= productstagecapacity[l];
           if(l==1 && t==16)
            sum(j in allproductsonstage1, s in microperiods16tomacroperiod)
production_time*
            productionquantity[j][l][s] + sum(i,j in allproductsonstage1, s in
microperiods16tomacroperiod)
            setuptime[j]*Pchangeover[i][j][l][s] + sum(s in microperiods16tomacroperiod)
sb[l][s] <= productstagecapacity[l];
           if(l==2 && t==1)
```

```
            sum(j in allproductsonstage2, s in microperiods1tomacroperiod)
production_time*
            productionquantity[j][l][s] + sum(i,j in allproductsonstage2, s in
microperiods1tomacroperiod)
            setuptime[j]*Pchangeover[i][j][l][s] + sum(s in microperiods1tomacroperiod)
sb[l][s] <= productstagecapacity[l];
           if(l==2 && t==2)
            sum(j in allproductsonstage2, s in microperiods2tomacroperiod)
production_time*
            productionquantity[j][l][s] + sum(i,j in allproductsonstage2, s in
microperiods2tomacroperiod)
            setuptime[j]*Pchangeover[i][j][l][s] + sum(s in microperiods2tomacroperiod)
sb[l][s] <= productstagecapacity[l];
           if(l==2 && t==3)
            sum(j in allproductsonstage2, s in microperiods3tomacroperiod)
production_time*
            productionquantity[j][l][s] + sum(i,j in allproductsonstage2, s in
microperiods3tomacroperiod)
            setuptime[j]*Pchangeover[i][j][l][s] + sum(s in microperiods3tomacroperiod)
sb[l][s] <= productstagecapacity[l];
           if(l==2 && t==4)
            sum(j in allproductsonstage2, s in microperiods4tomacroperiod)
production_time*
            productionquantity[j][l][s] + sum(i,j in allproductsonstage2, s in
microperiods4tomacroperiod)
            setuptime[j]*Pchangeover[i][j][l][s] + sum(s in microperiods4tomacroperiod)
sb[l][s] <= productstagecapacity[l];
           if(l==2 && t==5)
            sum(j in allproductsonstage2, s in microperiods5tomacroperiod)
production_time*
            productionquantity[j][l][s] + sum(i,j in allproductsonstage2, s in
microperiods5tomacroperiod)
            setuptime[j]*Pchangeover[i][j][l][s] + sum(s in microperiods5tomacroperiod)
sb[l][s] <= productstagecapacity[l];
           if(l==2 && t==6)
            sum(j in allproductsonstage2, s in microperiods6tomacroperiod)
production_time*
            productionquantity[j][l][s] + sum(i,j in allproductsonstage2, s in
microperiods6tomacroperiod)
            setuptime[j]*Pchangeover[i][j][l][s] + sum(s in microperiods6tomacroperiod)
sb[l][s] <= productstagecapacity[l];
          if(l==2 && t==7)
            sum(j in allproductsonstage2, s in microperiods7tomacroperiod)
production_time*
            productionquantity[j][l][s] + sum(i,j in allproductsonstage2, s in
microperiods7tomacroperiod)
            setuptime[j]*Pchangeover[i][j][l][s] + sum(s in microperiods7tomacroperiod)
sb[l][s] <= productstagecapacity[l];
          if(l==2 && t==8)
            sum(j in allproductsonstage2, s in microperiods8tomacroperiod)
production_time*
            productionquantity[j][l][s] + sum(i,j in allproductsonstage2, s in
microperiods8tomacroperiod)
            setuptime[j]*Pchangeover[i][j][l][s] + sum(s in microperiods8tomacroperiod)
sb[l][s] <= productstagecapacity[l];
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```
          if(l==2 && t==9)
            sum(j in allproductsonstage2, s in microperiods9tomacroperiod)
production_time*
            productionquantity[j][l][s] + sum(i,j in allproductsonstage2, s in
microperiods9tomacroperiod)
            setuptime[j]*Pchangeover[i][j][l][s] + sum(s in microperiods9tomacroperiod)
sb[l][s] <= productstagecapacity[l];
          if(l==2 && t==10)
            sum(j in allproductsonstage2, s in microperiods10tomacroperiod)
production_time*
            productionquantity[j][l][s] + sum(i,j in allproductsonstage2, s in
microperiods10tomacroperiod)
            setuptime[j]*Pchangeover[i][j][l][s] + sum(s in microperiods10tomacroperiod)
sb[l][s] <= productstagecapacity[l];
          if(l==2 && t==11)
            sum(j in allproductsonstage2, s in microperiods11tomacroperiod)
production_time*
            productionquantity[j][l][s] + sum(i,j in allproductsonstage2, s in
microperiods11tomacroperiod)
            setuptime[j]*Pchangeover[i][j][l][s] + sum(s in microperiods11tomacroperiod)
sb[l][s] <= productstagecapacity[l];
          if(l==2 && t==12)
            sum(j in allproductsonstage2, s in microperiods12tomacroperiod)
production_time*
            productionquantity[j][l][s] + sum(i,j in allproductsonstage2, s in
microperiods12tomacroperiod)
            setuptime[j]*Pchangeover[i][j][l][s] + sum(s in microperiods12tomacroperiod)
sb[l][s] <= productstagecapacity[l];
          if(l==2 && t==13)
            sum(j in allproductsonstage2, s in microperiods13tomacroperiod)
production_time*
            productionquantity[j][l][s] + sum(i,j in allproductsonstage2, s in
microperiods13tomacroperiod)
            setuptime[j]*Pchangeover[i][j][l][s] + sum(s in microperiods13tomacroperiod)
sb[l][s] <= productstagecapacity[l];
          if(l==2 && t==14)
            sum(j in allproductsonstage2, s in microperiods14tomacroperiod)
production_time*
            productionquantity[j][l][s] + sum(i,j in allproductsonstage2, s in
microperiods14tomacroperiod)
            setuptime[j]*Pchangeover[i][j][l][s] + sum(s in microperiods14tomacroperiod)
sb[l][s] <= productstagecapacity[l];
          if(l==2 && t==15)
            sum(j in allproductsonstage2, s in microperiods15tomacroperiod)
production_time*
            productionquantity[j][l][s] + sum(i,j in allproductsonstage2, s in
microperiods15tomacroperiod)
            setuptime[j]*Pchangeover[i][j][l][s] + sum(s in microperiods15tomacroperiod)
sb[l][s] <= productstagecapacity[l];
          if(l==2 && t==16)
            sum(j in allproductsonstage2, s in microperiods16tomacroperiod)
production_time*
            productionquantity[j][l][s] + sum(i,j in allproductsonstage2, s in
microperiods16tomacroperiod)
```

```
            setuptime[j]*Pchangeover[i][j][l][s] + sum(s in microperiods16tomacroperiod)
sb[l][s] <= productstagecapacity[l];
          if(l==3 && t==1)
            sum(j in allproductsonstage3, s in microperiods1tomacroperiod)
production_time*
            productionquantity[j][l][s] + sum(i,j in allproductsonstage3, s in
microperiods1tomacroperiod)
            setuptime[j]*Pchangeover[i][j][l][s] + sum(s in microperiods1tomacroperiod)
sb[l][s] <= productstagecapacity[l];
           if(l==3 && t==2)
            sum(j in allproductsonstage3, s in microperiods2tomacroperiod)
production_time*
            productionquantity[j][l][s] + sum(i,j in allproductsonstage3, s in
microperiods2tomacroperiod)
            setuptime[j]*Pchangeover[i][j][l][s] + sum(s in microperiods2tomacroperiod)
sb[l][s] <= productstagecapacity[l];
           if(l==3 && t==3)
            sum(j in allproductsonstage3, s in microperiods3tomacroperiod)
production_time*
            productionquantity[j][l][s] + sum(i,j in allproductsonstage3, s in
microperiods3tomacroperiod)
            setuptime[j]*Pchangeover[i][j][l][s] + sum(s in microperiods3tomacroperiod)
sb[l][s] <= productstagecapacity[l];
           if(l==3 && t==4)
            sum(j in allproductsonstage3, s in microperiods4tomacroperiod)
production_time*
            productionquantity[j][l][s] + sum(i,j in allproductsonstage3, s in
microperiods4tomacroperiod)
            setuptime[j]*Pchangeover[i][j][l][s] + sum(s in microperiods4tomacroperiod)
sb[l][s] <= productstagecapacity[l];
           if(l==3 && t==5)
            sum(j in allproductsonstage3, s in microperiods5tomacroperiod)
production_time*
            productionquantity[j][l][s] + sum(i,j in allproductsonstage3, s in
microperiods5tomacroperiod)
            setuptime[j]*Pchangeover[i][j][l][s] + sum(s in microperiods5tomacroperiod)
sb[l][s] <= productstagecapacity[l];
           if(l==3 && t==6)
            sum(j in allproductsonstage3, s in microperiods6tomacroperiod)
production_time*
            productionquantity[j][l][s] + sum(i,j in allproductsonstage3, s in
microperiods6tomacroperiod)
            setuptime[j]*Pchangeover[i][j][l][s] + sum(s in microperiods6tomacroperiod)
sb[l][s] <= productstagecapacity[l];
           if(l==3 && t==7)
            sum(j in allproductsonstage3, s in microperiods7tomacroperiod)
production_time*
            productionquantity[j][l][s] + sum(i,j in allproductsonstage3, s in
microperiods7tomacroperiod)
            setuptime[j]*Pchangeover[i][j][l][s] + sum(s in microperiods7tomacroperiod)
sb[l][s] <= productstagecapacity[l];
           if(l==3 && t==8)
            sum(j in allproductsonstage3, s in microperiods8tomacroperiod)
production_time*
```

```
            productionquantity[j][l][s] + sum(i,j in allproductsonstage3, s in
microperiods8tomacroperiod)
            setuptime[j]*Pchangeover[i][j][l][s] + sum(s in microperiods8tomacroperiod)
sb[l][s] <= productstagecapacity[l];
           if(l==3 && t==9)
            sum(j in allproductsonstage3, s in microperiods9tomacroperiod)
production_time*
            productionquantity[j][l][s] + sum(i,j in allproductsonstage3, s in
microperiods9tomacroperiod)
            setuptime[j]*Pchangeover[i][j][l][s] + sum(s in microperiods9tomacroperiod)
sb[l][s] <= productstagecapacity[l];
           if(l==3 && t==10)
            sum(j in allproductsonstage3, s in microperiods10tomacroperiod)
production_time*
            productionquantity[j][l][s] + sum(i,j in allproductsonstage3, s in
microperiods10tomacroperiod)
            setuptime[j]*Pchangeover[i][j][l][s] + sum(s in microperiods10tomacroperiod)
sb[l][s] <= productstagecapacity[l];
           if(l==3 && t==11)
            sum(j in allproductsonstage3, s in microperiods11tomacroperiod)
production_time*
            productionquantity[j][l][s] + sum(i,j in allproductsonstage3, s in
microperiods11tomacroperiod)
            setuptime[j]*Pchangeover[i][j][l][s] + sum(s in microperiods11tomacroperiod)
sb[l][s] <= productstagecapacity[l];
           if(l==3 && t==12)
            sum(j in allproductsonstage3, s in microperiods12tomacroperiod)
production_time*
            productionquantity[j][l][s] + sum(i,j in allproductsonstage3, s in
microperiods12tomacroperiod)
            setuptime[j]*Pchangeover[i][j][l][s] + sum(s in microperiods12tomacroperiod)
sb[l][s] <= productstagecapacity[l];
           if(l==3 && t==13)
            sum(j in allproductsonstage3, s in microperiods13tomacroperiod)
production_time*
            productionquantity[j][l][s] + sum(i,j in allproductsonstage3, s in
microperiods13tomacroperiod)
            setuptime[j]*Pchangeover[i][j][l][s] + sum(s in microperiods13tomacroperiod)
sb[l][s] <= productstagecapacity[l];
           if(l==3 && t==14)
            sum(j in allproductsonstage3, s in microperiods14tomacroperiod)
production_time*
            productionquantity[j][l][s] + sum(i,j in allproductsonstage3, s in
microperiods14tomacroperiod)
            setuptime[j]*Pchangeover[i][j][l][s] + sum(s in microperiods14tomacroperiod)
sb[l][s] <= productstagecapacity[l];
           if(l==3 && t==15)
            sum(j in allproductsonstage3, s in microperiods15tomacroperiod)
production_time*
            productionquantity[j][l][s] + sum(i,j in allproductsonstage3, s in
microperiods15tomacroperiod)
            setuptime[j]*Pchangeover[i][j][l][s] + sum(s in microperiods15tomacroperiod)
sb[l][s] <= productstagecapacity[l];
           if(l==3 && t==16)
```

```
            sum(j in allproductsonstage3, s in microperiods16tomacroperiod)
production_time*
            productionquantity[j][l][s] + sum(i,j in allproductsonstage3, s in
microperiods16tomacroperiod)
            setuptime[j]*Pchangeover[i][j][l][s] + sum(s in microperiods16tomacroperiod)
sb[l][s] <= productstagecapacity[l];
           if(l==4 && t==1)
            sum(j in allproductsonstage4, s in microperiods1tomacroperiod)
production_time*
            productionquantity[j][l][s] + sum(i,j in allproductsonstage4, s in
microperiods1tomacroperiod)
            setuptime[j]*Pchangeover[i][j][l][s] + sum(s in microperiods1tomacroperiod)
sb[l][s] <= productstagecapacity[l];
           if(l==4 && t==2)
            sum(j in allproductsonstage4, s in microperiods2tomacroperiod)
production_time*
            productionquantity[j][l][s] + sum(i,j in allproductsonstage4, s in
microperiods2tomacroperiod)
            setuptime[j]*Pchangeover[i][j][l][s] + sum(s in microperiods2tomacroperiod)
sb[l][s] <= productstagecapacity[l];
           if(l==4 && t==3)
            sum(j in allproductsonstage4, s in microperiods3tomacroperiod)
production_time*
            productionquantity[j][l][s] + sum(i,j in allproductsonstage4, s in
microperiods3tomacroperiod)
            setuptime[j]*Pchangeover[i][j][l][s] + sum(s in microperiods3tomacroperiod)
sb[l][s] <= productstagecapacity[l];
           if(l==4 && t==4)
            sum(j in allproductsonstage4, s in microperiods4tomacroperiod)
production_time*
            productionquantity[j][l][s] + sum(i,j in allproductsonstage4, s in
microperiods4tomacroperiod)
            setuptime[j]*Pchangeover[i][j][l][s] + sum(s in microperiods4tomacroperiod)
sb[l][s] <= productstagecapacity[l];
           if(l==4 && t==5)
            sum(j in allproductsonstage4, s in microperiods5tomacroperiod)
production_time*
            productionquantity[j][l][s] + sum(i,j in allproductsonstage4, s in
microperiods5tomacroperiod)
            setuptime[j]*Pchangeover[i][j][l][s] + sum(s in microperiods5tomacroperiod)
sb[l][s] <= productstagecapacity[l];
           if(l==4 && t==6)
            sum(j in allproductsonstage4, s in microperiods6tomacroperiod)
production_time*
            productionquantity[j][l][s] + sum(i,j in allproductsonstage4, s in
microperiods6tomacroperiod)
            setuptime[j]*Pchangeover[i][j][l][s] + sum(s in microperiods6tomacroperiod)
sb[l][s] <= productstagecapacity[l];
           if(l==4 && t==7)
            sum(j in allproductsonstage4, s in microperiods7tomacroperiod)
production_time*
            productionquantity[j][l][s] + sum(i,j in allproductsonstage4, s in
microperiods7tomacroperiod)
            setuptime[j]*Pchangeover[i][j][l][s] + sum(s in microperiods7tomacroperiod)
sb[l][s] <= productstagecapacity[l];
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           if(l==4 && t==8)
            sum(j in allproductsonstage4, s in microperiods8tomacroperiod)
production_time*
            productionquantity[j][l][s] + sum(i,j in allproductsonstage4, s in
microperiods8tomacroperiod)
            setuptime[j]*Pchangeover[i][j][l][s] + sum(s in microperiods8tomacroperiod)
sb[l][s] <= productstagecapacity[l];
           if(l==4 && t==9)
            sum(j in allproductsonstage4, s in microperiods9tomacroperiod)
production_time*
            productionquantity[j][l][s] + sum(i,j in allproductsonstage4, s in
microperiods9tomacroperiod)
            setuptime[j]*Pchangeover[i][j][l][s] + sum(s in microperiods9tomacroperiod)
sb[l][s] <= productstagecapacity[l];
           if(l==4 && t==10)
            sum(j in allproductsonstage4, s in microperiods10tomacroperiod)
production_time*
            productionquantity[j][l][s] + sum(i,j in allproductsonstage4, s in
microperiods10tomacroperiod)
            setuptime[j]*Pchangeover[i][j][l][s] + sum(s in microperiods10tomacroperiod)
sb[l][s] <= productstagecapacity[l];
           if(l==4 && t==11)
            sum(j in allproductsonstage4, s in microperiods11tomacroperiod)
production_time*
            productionquantity[j][l][s] + sum(i,j in allproductsonstage4, s in
microperiods11tomacroperiod)
            setuptime[j]*Pchangeover[i][j][l][s] + sum(s in microperiods11tomacroperiod)
sb[l][s] <= productstagecapacity[l];
           if(l==4 && t==12)
            sum(j in allproductsonstage4, s in microperiods12tomacroperiod)
production_time*
            productionquantity[j][l][s] + sum(i,j in allproductsonstage4, s in
microperiods12tomacroperiod)
            setuptime[j]*Pchangeover[i][j][l][s] + sum(s in microperiods12tomacroperiod)
sb[l][s] <= productstagecapacity[l];
           if(l==4 && t==13)
            sum(j in allproductsonstage4, s in microperiods13tomacroperiod)
production_time*
            productionquantity[j][l][s] + sum(i,j in allproductsonstage4, s in
microperiods13tomacroperiod)
            setuptime[j]*Pchangeover[i][j][l][s] + sum(s in microperiods13tomacroperiod)
sb[l][s] <= productstagecapacity[l];
           if(l==4 && t==14)
            sum(j in allproductsonstage4, s in microperiods14tomacroperiod)
production_time*
            productionquantity[j][l][s] + sum(i,j in allproductsonstage4, s in
microperiods14tomacroperiod)
            setuptime[j]*Pchangeover[i][j][l][s] + sum(s in microperiods14tomacroperiod)
sb[l][s] <= productstagecapacity[l];
           if(l==4 && t==15)
            sum(j in allproductsonstage4, s in microperiods15tomacroperiod)
production_time*
            productionquantity[j][l][s] + sum(i,j in allproductsonstage4, s in
microperiods15tomacroperiod)
```

```
            setuptime[j]*Pchangeover[i][j][l][s] + sum(s in microperiods15tomacroperiod)
sb[l][s] <= productstagecapacity[l];
           if(l==4 && t==16)
            sum(j in allproductsonstage4, s in microperiods16tomacroperiod)
production_time*
            productionquantity[j][l][s] + sum(i,j in allproductsonstage4, s in
microperiods16tomacroperiod)
            setuptime[j]*Pchangeover[i][j][l][s] + sum(s in microperiods16tomacroperiod)
sb[l][s] <= productstagecapacity[l];
           if(l==5 && t==1)
            sum(j in allproductsonstage5_1, s in microperiods1tomacroperiod)
production_time*
            productionquantity[j][l][s] + sum(i,j in allproductsonstage5_1, s in
microperiods1tomacroperiod)
            setuptime[j]*Pchangeover[i][j][l][s] + sum(s in microperiods1tomacroperiod)
sb[l][s] <= productstagecapacity[l];
           if(l==5 && t==2)
            sum(j in allproductsonstage5_1, s in microperiods1tomacroperiod)
production_time*
            productionquantity[j][l][s] + sum(i,j in allproductsonstage5_1, s in
microperiods1tomacroperiod)
            setuptime[j]*Pchangeover[i][j][l][s] + sum(s in microperiods1tomacroperiod)
sb[l][s] <= productstagecapacity[l];
           if(l==5 && t==3)
            sum(j in allproductsonstage5_1, s in microperiods1tomacroperiod)
production_time*
            productionquantity[j][l][s] + sum(i,j in allproductsonstage5_1, s in
microperiods1tomacroperiod)
            setuptime[j]*Pchangeover[i][j][l][s] + sum(s in microperiods1tomacroperiod)
sb[l][s] <= productstagecapacity[l];
           if(l==5 && t==4)
            sum(j in allproductsonstage5_1, s in microperiods1tomacroperiod)
production_time*
            productionquantity[j][l][s] + sum(i,j in allproductsonstage5_1, s in
microperiods1tomacroperiod)
            setuptime[j]*Pchangeover[i][j][l][s] + sum(s in microperiods1tomacroperiod)
sb[l][s] <= productstagecapacity[l];
           if(l==5 && t==5)
            sum(j in allproductsonstage5_1, s in microperiods1tomacroperiod)
production_time*
            productionquantity[j][l][s] + sum(i,j in allproductsonstage5_1, s in
microperiods1tomacroperiod)
            setuptime[j]*Pchangeover[i][j][l][s] + sum(s in microperiods1tomacroperiod)
sb[l][s] <= productstagecapacity[l];
           if(l==5 && t==6)
            sum(j in allproductsonstage5_1, s in microperiods1tomacroperiod)
production_time*
            productionquantity[j][l][s] + sum(i,j in allproductsonstage5_1, s in
microperiods1tomacroperiod)
            setuptime[j]*Pchangeover[i][j][l][s] + sum(s in microperiods1tomacroperiod)
sb[l][s] <= productstagecapacity[l];
           if(l==5 && t==7)
            sum(j in allproductsonstage5_1, s in microperiods1tomacroperiod)
production_time*
```

```
            productionquantity[j][l][s] + sum(i,j in allproductsonstage5_1, s in
microperiods1tomacroperiod)
            setuptime[j]*Pchangeover[i][j][l][s] + sum(s in microperiods1tomacroperiod)
sb[l][s] <= productstagecapacity[l];
           if(l==5 && t==8)
            sum(j in allproductsonstage5_1, s in microperiods1tomacroperiod)
production_time*
            productionquantity[j][l][s] + sum(i,j in allproductsonstage5_1, s in
microperiods1tomacroperiod)
            setuptime[j]*Pchangeover[i][j][l][s] + sum(s in microperiods1tomacroperiod)
sb[l][s] <= productstagecapacity[l];
           if(l==5 && t==9)
            sum(j in allproductsonstage5_1, s in microperiods1tomacroperiod)
production_time*
            productionquantity[j][l][s] + sum(i,j in allproductsonstage5_1, s in
microperiods1tomacroperiod)
            setuptime[j]*Pchangeover[i][j][l][s] + sum(s in microperiods1tomacroperiod)
sb[l][s] <= productstagecapacity[l];
           if(l==5 && t==10)
            sum(j in allproductsonstage5_1, s in microperiods1tomacroperiod)
production_time*
            productionquantity[j][l][s] + sum(i,j in allproductsonstage5_1, s in
microperiods1tomacroperiod)
            setuptime[j]*Pchangeover[i][j][l][s] + sum(s in microperiods1tomacroperiod)
sb[l][s] <= productstagecapacity[l];
           if(l==5 && t==11)
            sum(j in allproductsonstage5_1, s in microperiods1tomacroperiod)
production_time*
            productionquantity[j][l][s] + sum(i,j in allproductsonstage5_1, s in
microperiods1tomacroperiod)
            setuptime[j]*Pchangeover[i][j][l][s] + sum(s in microperiods1tomacroperiod)
sb[l][s] <= productstagecapacity[l];
           if(l==5 && t==12)
            sum(j in allproductsonstage5_1, s in microperiods1tomacroperiod)
production_time*
            productionquantity[j][l][s] + sum(i,j in allproductsonstage5_1, s in
microperiods1tomacroperiod)
            setuptime[j]*Pchangeover[i][j][l][s] + sum(s in microperiods1tomacroperiod)
sb[l][s] <= productstagecapacity[l];
           if(l==5 && t==13)
            sum(j in allproductsonstage5_1, s in microperiods1tomacroperiod)
production_time*
            productionquantity[j][l][s] + sum(i,j in allproductsonstage5_1, s in
microperiods1tomacroperiod)
            setuptime[j]*Pchangeover[i][j][l][s] + sum(s in microperiods1tomacroperiod)
sb[l][s] <= productstagecapacity[l];
           if(l==5 && t==14)
            sum(j in allproductsonstage5_1, s in microperiods1tomacroperiod)
production_time*
            productionquantity[j][l][s] + sum(i,j in allproductsonstage5_1, s in
microperiods1tomacroperiod)
            setuptime[j]*Pchangeover[i][j][l][s] + sum(s in microperiods1tomacroperiod)
sb[l][s] <= productstagecapacity[l];
           if(l==5 && t==15)
```

```
            sum(j in allproductsonstage5_1, s in microperiods1tomacroperiod)
production_time*
            productionquantity[j][l][s] + sum(i,j in allproductsonstage5_1, s in
microperiods1tomacroperiod)
            setuptime[j]*Pchangeover[i][j][l][s] + sum(s in microperiods1tomacroperiod)
sb[l][s] <= productstagecapacity[l];
           if(l==5 && t==16)
            sum(j in allproductsonstage5_1, s in microperiods1tomacroperiod)
production_time*
            productionquantity[j][l][s] + sum(i,j in allproductsonstage5_1, s in
microperiods1tomacroperiod)
            setuptime[j]*Pchangeover[i][j][l][s] + sum(s in microperiods1tomacroperiod)
sb[l][s] <= productstagecapacity[l];
           if(l==6 && t==1)
            sum(j in allproductsonstage5_2, s in microperiods1tomacroperiod)
production_time*
            productionquantity[j][l][s] + sum(i,j in allproductsonstage5_2, s in
microperiods1tomacroperiod)
            setuptime[j]*Pchangeover[i][j][l][s] + sum(s in microperiods1tomacroperiod)
sb[l][s] <= productstagecapacity[l];


           if(l==6 && t==2)
            sum(j in allproductsonstage5_2, s in microperiods2tomacroperiod)
production_time*
            productionquantity[j][l][s] + sum(i,j in allproductsonstage5_2, s in
microperiods2tomacroperiod)
            setuptime[j]*Pchangeover[i][j][l][s] + sum(s in microperiods2tomacroperiod)
sb[l][s] <= productstagecapacity[l];
           if(l==6 && t==3)
            sum(j in allproductsonstage5_2, s in microperiods3tomacroperiod)
production_time*
            productionquantity[j][l][s] + sum(i,j in allproductsonstage5_2, s in
microperiods3tomacroperiod)
            setuptime[j]*Pchangeover[i][j][l][s] + sum(s in microperiods3tomacroperiod)
sb[l][s] <= productstagecapacity[l];
           if(l==6 && t==4)
            sum(j in allproductsonstage5_2, s in microperiods4tomacroperiod)
production_time*
            productionquantity[j][l][s] + sum(i,j in allproductsonstage5_2, s in
microperiods4tomacroperiod)
            setuptime[j]*Pchangeover[i][j][l][s] + sum(s in microperiods4tomacroperiod)
sb[l][s] <= productstagecapacity[l];


           if(l==6 && t==5)
            sum(j in allproductsonstage5_2, s in microperiods5tomacroperiod)
production_time*
            productionquantity[j][l][s] + sum(i,j in allproductsonstage5_2, s in
microperiods5tomacroperiod)
            setuptime[j]*Pchangeover[i][j][l][s] + sum(s in microperiods5tomacroperiod)
sb[l][s] <= productstagecapacity[l];
           if(l==6 && t==6)
            sum(j in allproductsonstage5_2, s in microperiods6tomacroperiod)
production_time*
```

```
            productionquantity[j][l][s] + sum(i,j in allproductsonstage5_2, s in
microperiods6tomacroperiod)
            setuptime[j]*Pchangeover[i][j][l][s] + sum(s in microperiods6tomacroperiod)
sb[l][s] <= productstagecapacity[l];
           if(l==6 && t==7)
            sum(j in allproductsonstage5_2, s in microperiods7tomacroperiod)
production_time*
            productionquantity[j][l][s] + sum(i,j in allproductsonstage5_2, s in
microperiods7tomacroperiod)
            setuptime[j]*Pchangeover[i][j][l][s] + sum(s in microperiods7tomacroperiod)
sb[l][s] <= productstagecapacity[l];
           if(l==6 && t==8)
            sum(j in allproductsonstage5_2, s in microperiods8tomacroperiod)
production_time*
            productionquantity[j][l][s] + sum(i,j in allproductsonstage5_2, s in
microperiods8tomacroperiod)
            setuptime[j]*Pchangeover[i][j][l][s] + sum(s in microperiods8tomacroperiod)
sb[l][s] <= productstagecapacity[l];


           if(l==6 && t==9)
            sum(j in allproductsonstage5_2, s in microperiods9tomacroperiod)
production_time*
            productionquantity[j][l][s] + sum(i,j in allproductsonstage5_2, s in
microperiods9tomacroperiod)
            setuptime[j]*Pchangeover[i][j][l][s] + sum(s in microperiods9tomacroperiod)
sb[l][s] <= productstagecapacity[l];
           if(l==6 && t==10)
            sum(j in allproductsonstage5_2, s in microperiods10tomacroperiod)
production_time*
            productionquantity[j][l][s] + sum(i,j in allproductsonstage5_2, s in
microperiods10tomacroperiod)
            setuptime[j]*Pchangeover[i][j][l][s] + sum(s in microperiods10tomacroperiod)
sb[l][s] <= productstagecapacity[l];
           if(l==6 && t==11)
            sum(j in allproductsonstage5_2, s in microperiods11tomacroperiod)
production_time*
            productionquantity[j][l][s] + sum(i,j in allproductsonstage5_2, s in
microperiods11tomacroperiod)
            setuptime[j]*Pchangeover[i][j][l][s] + sum(s in microperiods11tomacroperiod)
sb[l][s] <= productstagecapacity[l];
           if(l==6 && t==12)
            sum(j in allproductsonstage5_2, s in microperiods12tomacroperiod)
production_time*
            productionquantity[j][l][s] + sum(i,j in allproductsonstage5_2, s in
microperiods12tomacroperiod)
            setuptime[j]*Pchangeover[i][j][l][s] + sum(s in microperiods12tomacroperiod)
sb[l][s] <= productstagecapacity[l];


           if(l==6 && t==13)
            sum(j in allproductsonstage5_2, s in microperiods13tomacroperiod)
production_time*
            productionquantity[j][l][s] + sum(i,j in allproductsonstage5_2, s in
microperiods13tomacroperiod)
```

```
            setuptime[j]*Pchangeover[i][j][l][s] + sum(s in microperiods13tomacroperiod)
sb[l][s] <= productstagecapacity[l];
           if(l==6 && t==14)
            sum(j in allproductsonstage5_2, s in microperiods14tomacroperiod)
production_time*
            productionquantity[j][l][s] + sum(i,j in allproductsonstage5_2, s in
microperiods14tomacroperiod)
            setuptime[j]*Pchangeover[i][j][l][s] + sum(s in microperiods14tomacroperiod)
sb[l][s] <= productstagecapacity[l];
           if(l==6 && t==15)
            sum(j in allproductsonstage5_2, s in microperiods15tomacroperiod)
production_time*
            productionquantity[j][l][s] + sum(i,j in allproductsonstage5_2, s in
microperiods15tomacroperiod)
            setuptime[j]*Pchangeover[i][j][l][s] + sum(s in microperiods15tomacroperiod)
sb[l][s] <= productstagecapacity[l];
           if(l==6 && t==16)
            sum(j in allproductsonstage5_2, s in microperiods16tomacroperiod)
production_time*
            productionquantity[j][l][s] + sum(i,j in allproductsonstage5_2, s in
microperiods16tomacroperiod)
            setuptime[j]*Pchangeover[i][j][l][s] + sum(s in microperiods16tomacroperiod)
sb[l][s] <= productstagecapacity[l];
           }

      //Production Flow between Stages (Sequence & Position) Constraints
       forall (j in allproductsonstage1, p in allproductsonstage2, l in
productionstages:l<=L-1, s in microperiods)
         Position_Sequence1:{
         if (j in family1stage1 && p in family1stage2 && l==1)
                  BigM * (stagesetup[j][l][s]-1) + sb[l][s] + E_setuptime[l][s]<=
BigM*(1-stagesetup[p][l+1][s])+
                  sb[l+1][s] + E_setuptime[l+1][s];
         if (j in family2stage1 && p in family2stage2 && l==1)
                  BigM * (stagesetup[j][l][s]-1) + sb[l][s] + E_setuptime[l][s]<=
BigM*(1-stagesetup[p][l+1][s])+
                  sb[l+1][s] + E_setuptime[l+1][s];
         if (j in family3stage1 && p in family3stage2 && l==1)
                  BigM * (stagesetup[j][l][s]-1) + sb[l][s] + E_setuptime[l][s]<=
BigM*(1-stagesetup[p][l+1][s])+
                  sb[l+1][s] + E_setuptime[l+1][s];
         if (j in family4stage1 && p in family4stage2 && l==1)
                  BigM * (stagesetup[j][l][s]-1) + sb[l][s] + E_setuptime[l][s]<=
BigM*(1-stagesetup[p][l+1][s])+
                  sb[l+1][s] + E_setuptime[l+1][s];
         if (j in family5stage1 && p in family5stage2 && l==1)
                  BigM * (stagesetup[j][l][s]-1) + sb[l][s] + E_setuptime[l][s]<=
BigM*(1-stagesetup[p][l+1][s])+
                  sb[l+1][s] + E_setuptime[l+1][s];
         if (j in family6stage1 && p in family6stage2 && l==1)
                  BigM * (stagesetup[j][l][s]-1) + sb[l][s] + E_setuptime[l][s]<=
BigM*(1-stagesetup[p][l+1][s])+
                  sb[l+1][s] + E_setuptime[l+1][s];
         if (j in family7stage1 && p in family7stage2 && l==1)
```

```
                BigM * (stagesetup[j][l][s]-1) + sb[l][s] + E_setuptime[l][s]<=
BigM*(1-stagesetup[p][l+1][s])+
                sb[l+1][s] + E_setuptime[l+1][s];
        if (j in family8stage1 && p in family8stage2 && l==1)
                BigM * (stagesetup[j][l][s]-1) + sb[l][s] + E_setuptime[l][s]<=
BigM*(1-stagesetup[p][l+1][s])+
                sb[l+1][s] + E_setuptime[l+1][s];
        if (j in family9stage1 && p in family9stage2 && l==1)
                BigM * (stagesetup[j][l][s]-1) + sb[l][s] + E_setuptime[l][s]<=
BigM*(1-stagesetup[p][l+1][s])+
                sb[l+1][s] + E_setuptime[l+1][s];

        }
     forall (j in allproductsonstage2, p in allproductsonstage3, l in
productionstages:l<=L-1, s in microperiods)
        Position_Sequence2:{
        if (j in family10stage2 && p in family1stage3 && l==2)
                BigM * (stagesetup[j][l][s]-1) + B_setuptime[l][s] +
production_time*productionquantity[j][l][s]
                <= BigM*(1-stagesetup[p][l+1][s])+ B_setuptime[l+1][s] +
production_time*productionquantity[p][l+1][s];
        if (j in family11stage2 && p in family2stage3 && l==2)
                BigM * (stagesetup[j][l][s]-1) + B_setuptime[l][s] +
production_time*productionquantity[j][l][s]
                <= BigM*(1-stagesetup[p][l+1][s])+ B_setuptime[l+1][s] +
production_time*productionquantity[p][l+1][s];
        if (j in family3stage2 && p in family3stage3 && l==2)
                BigM * (stagesetup[j][l][s]-1) + B_setuptime[l][s] +
production_time*productionquantity[j][l][s]
                <= BigM*(1-stagesetup[p][l+1][s])+ B_setuptime[l+1][s] +
production_time*productionquantity[p][l+1][s];
        if (j in family4stage2 && p in family4stage3 && l==2)
                BigM * (stagesetup[j][l][s]-1) + B_setuptime[l][s] +
production_time*productionquantity[j][l][s]
                <= BigM*(1-stagesetup[p][l+1][s])+ B_setuptime[l+1][s] +
production_time*productionquantity[p][l+1][s];
        if (j in family5stage2 && p in family5stage3 && l==2)
                BigM * (stagesetup[j][l][s]-1) + B_setuptime[l][s] +
production_time*productionquantity[j][l][s]
                <= BigM*(1-stagesetup[p][l+1][s])+ B_setuptime[l+1][s] +
production_time*productionquantity[p][l+1][s];
        if (j in family6stage2 && p in family6stage3 && l==2)
                BigM * (stagesetup[j][l][s]-1) + B_setuptime[l][s] +
production_time*productionquantity[j][l][s]
                <= BigM*(1-stagesetup[p][l+1][s])+ B_setuptime[l+1][s] +
production_time*productionquantity[p][l+1][s];
        if (j in family7stage2 && p in family7stage3 && l==2)
                BigM * (stagesetup[j][l][s]-1) + B_setuptime[l][s] +
production_time*productionquantity[j][l][s]
                <= BigM*(1-stagesetup[p][l+1][s])+ B_setuptime[l+1][s] +
production_time*productionquantity[p][l+1][s];
        if (j in family12stage2 && p in family8stage3 && l==2)
                BigM * (stagesetup[j][l][s]-1) + B_setuptime[l][s] +
production_time*productionquantity[j][l][s]
```

```
                <= BigM*(1-stagesetup[p][l+1][s])+ B_setuptime[l+1][s] +
production_time*productionquantity[p][l+1][s];

        }
      forall (j in allproductsonstage3, p in allproductsonstage4, l in
productionstages:l<=L-1, s in microperiods)
        Position_Sequence3:{
        if (j in family9stage3 && p in family1stage4 && l==3)
                BigM * (stagesetup[j][l][s]-1) + B_setuptime[l][s] +
production_time*productionquantity[j][l][s]
                <= BigM*(1-stagesetup[p][l+2][s])+ B_setuptime[l+2][s] +
production_time*productionquantity[p][l+2][s];
        if (j in family10stage3 && p in family2stage4 && l==3)
                BigM * (stagesetup[j][l][s]-1) + B_setuptime[l][s] +
production_time*productionquantity[j][l][s]
                <= BigM*(1-stagesetup[p][l+2][s])+ B_setuptime[l+2][s] +
production_time*productionquantity[p][l+2][s];
        if (j in family11stage3 && p in family3stage4 && l==3)
                BigM * (stagesetup[j][l][s]-1) + B_setuptime[l][s] +
production_time*productionquantity[j][l][s]
                <= BigM*(1-stagesetup[p][l+2][s])+ B_setuptime[l+2][s] +
production_time*productionquantity[p][l+2][s];
        if (j in family12stage3 && p in family4stage4 && l==3)
                BigM * (stagesetup[j][l][s]-1) + B_setuptime[l][s] +
production_time*productionquantity[j][l][s]
                <= BigM*(1-stagesetup[p][l+2][s])+ B_setuptime[l+2][s] +
production_time*productionquantity[p][l+2][s];
        }
      forall (j in allproductsonstage4, p in allproductsonstage5_1, l in
productionstages:l<=L-1, s in microperiods)
        Position_Sequence4:{
        if (j in family5stage4 && p in family1stage5_1 && l==4)
                BigM * (stagesetup[j][l][s]-1) + B_setuptime[l][s] +
production_time*productionquantity[j][l][s]
                <= BigM*(1-stagesetup[p][l+1][s])+ B_setuptime[l+1][s] +
production_time*productionquantity[p][l+1][s];
        }
      forall (j in allproductsonstage4, p in allproductsonstage5_2, l in
productionstages:l<=L-1, s in microperiods)
        Position_Sequence5:{
        if (j in family5stage4 && p in family1stage5_2 && l==4)
                BigM * (stagesetup[j][l][s]-1) + B_setuptime[l][s] +
production_time*productionquantity[j][l][s]
                <= BigM*(1-stagesetup[p][l+2][s])+ B_setuptime[l+2][s] +
production_time*productionquantity[p][l+2][s];
        if (j in family6stage4 && p in family2stage5_2 && l==4)
                BigM * (stagesetup[j][l][s]-1) + B_setuptime[l][s] +
production_time*productionquantity[j][l][s]
                <= BigM*(1-stagesetup[p][l+2][s])+ B_setuptime[l+2][s] +
production_time*productionquantity[p][l+2][s];
        }

//Upper bound on production quantities
       forall (j in products, l in productionstages, s in microperiods)
            UB_ProductionQTY:{
```

```
            if(j in allproductsonstage1 && l==1)
                productionquantity[j][l][s] <=
(productstagecapacity[l]/production_time) * stagesetup[j][l][s];
              if(j in allproductsonstage2 && l==2)
                productionquantity[j][l][s] <=
(productstagecapacity[l]/production_time) * stagesetup[j][l][s];
              if(j in allproductsonstage3 && l==3)
                productionquantity[j][l][s] <=
(productstagecapacity[l]/production_time) * stagesetup[j][l][s];
              if(j in allproductsonstage4 && l==4)
                productionquantity[j][l][s] <=
(productstagecapacity[l]/production_time) * stagesetup[j][l][s];
              if(j in allproductsonstage5_1 && l==5)
                productionquantity[j][l][s] <=
(productstagecapacity[l]/production_time) * stagesetup[j][l][s];
              if(j in allproductsonstage5_2 && l==6)
                productionquantity[j][l][s] <=
(productstagecapacity[l]/production_time) * stagesetup[j][l][s];
                }

      //Lower bound on production quantities - Minimum Lot-size needed / Triangle
inequality not always true
        forall (j in products, l in productionstages, s in microperiods)
              min_litsizes:{
                if(j in allproductsonstage1 && l==1)
                  productionquantity[j][l][s] >= min_lotsize* (stagesetup[j][l][s]-
stagesetup[j][l][s-1]);
                if(j in allproductsonstage2 && l==2)
                  productionquantity[j][l][s] >= min_lotsize* (stagesetup[j][l][s]-
stagesetup[j][l][s-1]);
                if(j in allproductsonstage3 && l==3)
                  productionquantity[j][l][s] >= min_lotsize* (stagesetup[j][l][s]-
stagesetup[j][l][s-1]);
                if(j in allproductsonstage4 && l==4)
                  productionquantity[j][l][s] >= min_lotsize* (stagesetup[j][l][s]-
stagesetup[j][l][s-1]);
                if(j in allproductsonstage5_1 && l==5)
                  productionquantity[j][l][s] >= min_lotsize* (stagesetup[j][l][s]-
stagesetup[j][l][s-1]);
                if(j in allproductsonstage5_2 && l==6)
                  productionquantity[j][l][s] >= min_lotsize* (stagesetup[j][l][s]-
stagesetup[j][l][s-1]);
                  }

//      forall(j in products, l in productionstages)
//            stagesetup[j][l][0]==0;

      //Only one production stage setup allowed in each microperiod
        forall (l in productionstages, s in microperiods)
               Onlyone_Setup1:
                  sum(j in products)
                        stagesetup[j][l][s]==1;

      //Only one product changeover allowed in each microperiod
        forall (l in productionstages, s in microperiods:s>=2)
```

```
            Onlyone_Changeover: {
            if (l==1)
                sum (i,j in allproductsonstage1)
                      Pchangeover[i][j][l][s]==1;
            if (l==2)
                sum (i,j in allproductsonstage2)
                      Pchangeover[i][j][l][s]==1;
            if (l==3)
                sum (i,j in allproductsonstage3)
                      Pchangeover[i][j][l][s]==1;
            if (l==4)
                sum (i,j in allproductsonstage4)
                      Pchangeover[i][j][l][s]==1;
            if (l==5)
                sum (i,j in allproductsonstage5_1)
                      Pchangeover[i][j][l][s]==1;
            if (l==6)
                sum (i,j in allproductsonstage5_2)
                      Pchangeover[i][j][l][s]==1;
            }

       //Setup Spliting idea constrinats
         forall (l in productionstages, s in microperiods:s>=2)
         Setup_Splitting:
         {
         if (l==1)
                  E_setuptime[l][s-1] + B_setuptime[l][s] ==
                  sum (i,j in allproductsonstage1) setuptime[j]*Pchangeover[i][j][l][s];
         if (l==2)
                  E_setuptime[l][s-1] + B_setuptime[l][s] ==
                  sum (i,j in allproductsonstage2) setuptime[j]*Pchangeover[i][j][l][s];
         if (l==3)
                  E_setuptime[l][s-1] + B_setuptime[l][s] ==
                  sum (i,j in allproductsonstage3) setuptime[j]*Pchangeover[i][j][l][s];
         if (l==4)
                  E_setuptime[l][s-1] + B_setuptime[l][s] ==
                  sum (i,j in allproductsonstage4) setuptime[j]*Pchangeover[i][j][l][s];
            if (l==5)
                  E_setuptime[l][s-1] + B_setuptime[l][s] ==
                  sum (i,j in allproductsonstage5_1)
setuptime[j]*Pchangeover[i][j][l][s];
            if (l==6)
                  E_setuptime[l][s-1] + B_setuptime[l][s] ==
                  sum (i,j in allproductsonstage5_2)
setuptime[j]*Pchangeover[i][j][l][s];
         }

      //Linking between product changeover and machine setup constrinats
            forall (i,j in products, l in productionstages, s in microperiods:s>=2)
            Changeover_setup:
            {
          if(l==1)
            Pchangeover[i][j][l][s] >= stagesetup[i][l][s-1]+ stagesetup[j][l][s]-1;
            if(l==2)
```

```
                  Pchangeover[i][j][l][s] >= stagesetup[i][l][s-1]+ stagesetup[j][l][s]-
1;
            if(l==3)
                  Pchangeover[i][j][l][s] >= stagesetup[i][l][s-1]+ stagesetup[j][l][s]-
1;
            if(l==4)
                  Pchangeover[i][j][l][s] >= stagesetup[i][l][s-1]+ stagesetup[j][l][s]-
1;
            if(l==5)
                  Pchangeover[i][j][l][s] >= stagesetup[i][l][s-1]+ stagesetup[j][l][s]-
1;
            if(l==6)
                  Pchangeover[i][j][l][s] >= stagesetup[i][l][s-1]+ stagesetup[j][l][s]-
1;
            }

        //Maximum Inventory Level
          //forall (j in products, t in macroperiods)
           //  Max_Inv:
            //    inventory[j][t]<= max_inv;

//      //Maintain Stock level beyond the planning horizon
//        forall (j in products)
//          Inventory_EPH1:
//                inventory[j][T]==initial_inv;
                                          }
```