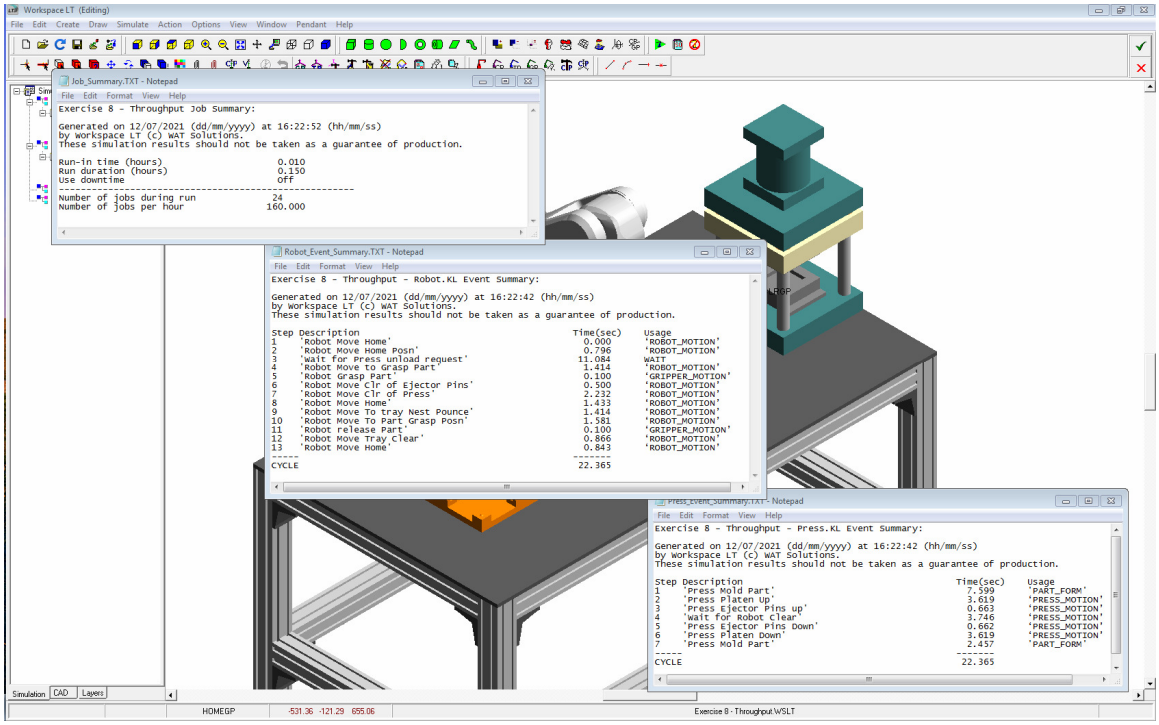
Workspace LT (Editing)
Job_Summary.TXT - Notepad
Exercise 8 - Throughput Job Summary:
Generated on 12/07/2021 (dd/mm/yyyy) at 16:22:52 (hh/mm/ss)
by Workspace LT (c) WAT Solutions.
These simulation results should not be taken as a guarantee of production.
Run-in time (hours) 0.010
Run duration (hours) 0.150
Use downtime Off
Number of jobs during run 24
Number of jobs per hour 160.000
Robot_Event_Summary.TXT - Notepad
Exercise 8 - Throughput - Robot.KL Event Summary:
Generated on 12/07/2021 (dd/mm/yyyy) at 16:22:42 (hh/mm/ss)
by Workspace LT (c) WAT Solutions.
These simulation results should not be taken as a guarantee of production.
Step Description Time(sec) Usage
1 'Robot Move Home' 0.000 'ROBOT_MOTION'
2 'Robot Move Home Posn' 0.796 'ROBOT_MOTION'
3 'Wait for Press unload request' 11.084 WAIT
4 'Robot Move to Grasp Part' 1.414 'ROBOT_MOTION'
5 'Robot Grasp Part' 0.100 'GRIPPER_MOTION'
6 'Robot Move Clr of Ejector Pins' 0.500 'ROBOT_MOTION'
7 'Robot Move Clr of Press' 2.232 'ROBOT_MOTION'
8 'Robot Move Home' 1.433 'ROBOT_MOTION'
9 'Robot Move To tray Nest Pounce' 1.414 'ROBOT_MOTION'
10 'Robot Move To Part Grasp Posn' 1.581 'ROBOT_MOTION'
11 'Robot release Part' 0.100 'GRIPPER_MOTION'
12 'Robot Move Tray Clear' 0.866 'ROBOT_MOTION'
13 'Robot Move Home' 0.843 'ROBOT_MOTION'
CYCLE 22.365
Press_Event_Summary.TXT - Notepad
Exercise 8 - Throughput - Press.KL Event Summary:
Generated on 12/07/2021 (dd/mm/yyyy) at 16:22:42 (hh/mm/ss)
by Workspace LT (c) WAT Solutions.
These simulation results should not be taken as a guarantee of production.
Step Description Time(sec) Usage
1 'Press Mold Part' 7.599 'PART_FORM'
2 'Press Platen Up' 3.619 'PRESS_MOTION'
3 'Press Ejector Pins up' 0.663 'PRESS_MOTION'
4 'Wait for Robot Clear' 3.746 'PRESS_MOTION'
5 'Press Ejector Pins Down' 0.662 'PRESS_MOTION'
6 'Press Platen Down' 3.619 'PRESS_MOTION'
7 'Press Mold Part' 2.457 'PART_FORM'
CYCLE 22.365
Simulation
CAD
Layers
HOMEGP
-531.36 -121.29 655.06
Exercise 8 - Throughput.WSLT

Exercise 8 - Throughput Analysis

Objectives:

- Create basic robot programs in simulation.
- Understanding Logic statements.
- Using an end of arm gripper to manipulate parts.
- Using assigned variables and a Constance
- Using routines to assign various robot tasks.
- Use of Inputs and outputs to control the simulation flow.
- Robot program optimization using throughput analysis

Materials;

- Workspace LT© simulation software.
- Workspace LT© project file "Exercise 8 - Throughput Analysis.WSLT".
- Manual "Workspace LT© User Guide.pdf".

Helpful Hint; Before starting this exercise, review the User Guide sections;

- 6.3 - Comments and Workspace commands
- 6.4.5 Variables
- 6.7.1 - INTEGER and REAL functions
- 8.2.1 DIN..DOUT
- 9.1.1 - IF ... ENDIF
- 9.2.3 - WHILE ... ENDWHILE
- 14.15 - Creating Mechanisms
- 15. - Throughput Statistics

1) Procedure: Create a Robot track
   a) Open Workspace LT simulation software.
   b) Open the project file "Exercise 8 - Throughput Analysis.WSLT".
   c) Add a track for robot ABB_1200_5_90. Enter the Track Name "Robot" and select the Language "KAREL 2".
   d) Open the text editor to view the program track Robot.KL. Using the mouse, select the "Robot.KL" twice in rapid successions to open the Robot.KL track in the program editor.
   e) Insert the following text to complete the robot program.

```
PROGRAM Robot
-- Workspace LT KAREL 2 Program for ABB_1200_5_90 Robot
```

```
CONST
  PARTSTOTAL=27

VAR
  PartsCount : INTEGER
  ROW : INTEGER
  COLUMN : INTEGER
  TRAYNO : INTEGER
  FULLTRAY: BOOLEAN

  --! SIGNALDEF DOUT[1],TRACK     -- Robot Clear Press
  --! SIGNALDEF DIN[1],Press.KL,1  -- Press Requests Part unload

ROUTINE PressUnload
Begin
  WAIT FOR DIN[1]=ON
  $TERMTYPE=FINE
  $MOTYPE=LINEAR
  MOVE RELATIVE VEC(0,200,0)
  --! COPYOBJECTALT 'PRESSPART','PART'
  --! MakeInvisible 1,'PRESSPART'
  CLOSE HAND 1
  -- ! GRASPOBJ 'NOPARENT.PART'
  --! LABELEVENT 'Robot Move Clr of Ejector Pins',2
  MOVE RELATIVE VEC(0,0,10)
  MOVE AWAY 300.00
END PressUnload

ROUTINE PalletLoad
Begin
  $TERMTYPE=FINE
  $MOTYPE=LINEAR
  MOVE RELATIVE VEC((300-COLUMN*100),(-300+ROW*100),0)
  --! LABELEVENT 'Robot Move To Part Grasp Posn',2
  MOVE RELATIVE VEC(0,0,(-325.5+(TRAYNO*75.5)))
  OPEN HAND 1
  IF TRAYNO=1 THEN
    -- ! ATTACHOBJALT 'TRAY1','NOPARENT.PART'
  ENDIF
  IF TRAYNO=2 THEN
    -- ! ATTACHOBJALT 'TRAY2','NOPARENT.PART'
  ENDIF
  IF TRAYNO=3 THEN
    -- ! ATTACHOBJALT 'TRAY3','NOPARENT.PART'
  ENDIF
  MOVE RELATIVE VEC(0,0,75)
```

```
    COLUMN=COLUMN+1
    IF COLUMN=4 THEN
      ROW=ROW+1
      COLUMN=1
      IF ROW=4 THEN
        FULLTRAY=TRUE
        ROW=1
      ENDIF
    ENDIF
  END Palletload

  ROUTINE GETEMPTYTRAY
  BEGIN
    $TERMTYPE=FINE
    $MOTYPE=JOINT
    MOVE TO PALLETCLRGP
    MOVE TO TRAYSTACKCLR
    $MOTYPE=LINEAR
    TRAYNO=TRAYNO+1
    MOVE RELATIVE VEC(0,0,(-200-(25*TRAYNO)))
    CLOSE HAND 1
    IF TRAYNO=1 THEN
      -- ! GRASPOBJ 'TRAY1'
    ENDIF
    IF TRAYNO=2 THEN
      -- ! GRASPOBJ 'TRAY2'
    ENDIF
    IF TRAYNO=3 THEN
      -- ! GRASPOBJ 'TRAY3'
    ENDIF
    MOVE AWAY (200+(25.00*TRAYNO))
    MOVE RELATIVE VEC(350,0,0)
    MOVE RELATIVE VEC(0,0,(-350.5+(75.5*TRAYNO)))
    OPEN HAND 1
    MOVE AWAY 75.00
    FULLTRAY=FALSE
  END GETEMPTYTRAY

  BEGIN
    $USEMAXACCEL=TRUE
    %INCLUDE Robot#
    $MOTYPE=JOINT
    $TERMTYPE=FINE
    $UTOOL = POS(45,0,134,0,-90,0,")
    DOUT[1]=OFF
    PARTSCOUNT=0
```

```
  ROW=1
  COLUMN=1
  FULLTRAY=TRUE
  TRAYNO=0
  MOVE TO HOMEGP
REPEAT
  IF FULLTRAY=TRUE THEN
    GETEMPTYTRAY
    FULLTRAY=FALSE
  ENDIF
  $MOTYPE=JOINT
  $TERMTYPE=NODECEL
  MOVE TO HOMEGP
  $TERMTYPE=FINE
  $MOTYPE=JOINT
  MOVE TO PRESSCLRGP
  PressUnload
  DOUT[1]=ON
  DELAY 500
  DOUT[1]=OFF
  $MOTYPE=JOINT
  $TERMTYPE=NODECEL
  MOVE TO HOMEGP
  $TERMTYPE=FINE
  MOVE TO PALLETCLRGP
  PalletLoad
  PARTSCOUNT=PARTSCOUNT+1
  IF FULLTRAY=FALSE THEN
    $MOTYPE=JOINT
    $TERMTYPE=NODECEL
    MOVE TO HOMEGP
  ENDIF
  IF PARTSCOUNT=PARTSTOTAL THEN
    $MOTYPE=JOINT
    $TERMTYPE=FINE
    MOVE TO HOMEGP
  ENDIF
  --! ENDOFJOB
UNTIL PARTSCOUNT=PARTSTOTAL
END Robot
```

f) Comment the robot track to for ease of understanding by others

g) Save the project model .

2) Procedure: Create a press track

a) Open Workspace LT simulation software.

b) Add a track for the mechanism "MACHINEMOLD. Enter the Track Name "Press" and select the Language "KAREL 2".
c) Open the text editor to view the program track Press.KL. Using the mouse , select the "Press.KL" twice in rapid successions to open the "Press.KL" track in the program editor.
d) Insert the following text to complete the robot program.

```
PROGRAM Press

CONST
  PartsTotal=27

VAR
  PartsCount : INTEGER

  PRESS_UP : AUXPOS
  PRESS_DWN : AUXPOS
  PINS_UP : AUXPOS
  PINS_DWN : AUXPOS

  --! SIGNALDEF DOUT[1],TRACK     -- request robot unload part
  --! SIGNALDEF DIN[1],Robot.KL,1  -- Robot clear press

BEGIN
  $USEMAXACCEL=TRUE
  %INCLUDE Press#
  $MOTYPE=JOINT
  PartsCount=0
  DOUT[1]=OFF
  PartsCount=0
  --! MakeInvisible 1,'PRESSPART'

REPEAT
  MOVE AUX TO PRESS_DWN
  Delay 10000
  --! MakeVisible 1,'PRESSPART'
  MOVE AUX TO PRESS_UP
  MOVE AUX TO PINS_UP
  DOUT[1]=on
  WAIT FOR DIN[1]=ON
  DOUT[1]=OFF
  MOVE AUX TO PINS_DWN
  PartsCount=PartsCount+1
UNTIL PartsCount=PartsTotal
END Press
```

e) Need to record teach points
f) Comment the robot track to for ease of understanding by others.
g) Save the project model .
h) Using the mouse select (Play simulation) observe the simulation to verify the simulation.

3) Procedure: Setup for throughput analysis.
   a) Open the text editor to view the program track Robot.KL. Using the mouse , select the "Robot.KL" twice in rapid successions to open the Robot.KL track in the program editor.
   b) Insert the following changes to the existing Robot.KL track. Do not remove existing comments.

```
PROGRAM Robot
--  Workspace LT KAREL 2 Program for ABB_1200_5_90 Robot

CONST
  PARTSTOTAL=27

VAR
  PartsCount : INTEGER
  ROW : INTEGER
  COLUMN : INTEGER
  TRAYNO : INTEGER
  FULLTRAY: BOOLEAN

  --! SIGNALDEF DOUT[1],TRACK     -- Robot Clear Press
  --! SIGNALDEF DIN[1],Press.KL,1  -- Press Requests Part unload

  -- ! LABELUSAGE 'ROBOT_MOTION',2
  -- ! LABELUSAGE 'PRESS_MOTION',3
  -- ! LABELUSAGE 'GRIPPER_MOTION',4
  -- ! LABELUSAGE 'PART_FORM',5

ROUTINE PressUnload
Begin
  --! LABELEVENT 'Wait for Press unload request',0
  WAIT FOR DIN[1]=ON
  $TERMTYPE=FINE
  $MOTYPE=LINEAR
  --! LABELEVENT 'Robot Move to Grasp Part',2
  MOVE RELATIVE VEC(0,200,0)
  --! COPYOBJECTALT 'PRESSPART','PART'
  --! MakeInvisible 1,'PRESSPART'
  --! LABELEVENT 'Robot Grasp Part',4
  CLOSE HAND 1
```

```
  -- ! GRASPOBJ 'NOPARENT.PART'
  --! LABELEVENT 'Robot Move Clr of Ejector Pins',2
  MOVE RELATIVE VEC(0,0,10)
  --! LABELEVENT 'Robot Move Clr of Press',2
  MOVE AWAY 300.00
END PressUnload

ROUTINE PalletLoad
Begin
  $TERMTYPE=FINE
  $MOTYPE=LINEAR
  --! LABELEVENT 'Robot Move To tray Nest Pounce',2
  MOVE RELATIVE VEC((300-COLUMN*100),(-300+ROW*100),0)
  --! LABELEVENT 'Robot Move To Part Grasp Posn',2
  MOVE RELATIVE VEC(0,0,(-325.5+(TRAYNO*75.5)))
  --! LABELEVENT 'Robot release Part',4
  OPEN HAND 1
  IF TRAYNO=1 THEN
    -- ! ATTACHOBJALT 'TRAY1','NOPARENT.PART'
  ENDIF
  IF TRAYNO=2 THEN
    -- ! ATTACHOBJALT 'TRAY2','NOPARENT.PART'
  ENDIF
  IF TRAYNO=3 THEN
    -- ! ATTACHOBJALT 'TRAY3','NOPARENT.PART'
  ENDIF
  --! LABELEVENT 'Robot Move Tray Clear',2
  MOVE RELATIVE VEC(0,0,75)
  COLUMN=COLUMN+1
  IF COLUMN=4 THEN
    ROW=ROW+1
    COLUMN=1
    IF ROW=4 THEN
      FULLTRAY=TRUE
      ROW=1
    ENDIF
  ENDIF
END Palletload

ROUTINE GETEMPTYTRAY
BEGIN
  $TERMTYPE=FINE
  $MOTYPE=JOINT
  --! LABELEVENT 'Robot Move to Tray Stack',2
  MOVE TO PALLETCLRGP
  MOVE TO TRAYSTACKCLR
```

```
  $MOTYPE=LINEAR
  TRAYNO=TRAYNO+1
  --! LABELEVENT 'Robot Move to Tray Grasp',2
  MOVE RELATIVE VEC(0,0,(-200-(25*TRAYNO)))
  --! LABELEVENT 'Robot Grasp Tray',4
  CLOSE HAND 1
  IF TRAYNO=1 THEN
    -- ! GRASPOBJ 'TRAY1'
  ENDIF
  IF TRAYNO=2 THEN
    -- ! GRASPOBJ 'TRAY2'
  ENDIF
  IF TRAYNO=3 THEN
    -- ! GRASPOBJ 'TRAY3'
  ENDIF
  --! LABELEVENT 'Robot Move to Tray Stack Clear',2
  MOVE AWAY (200+(25.00*TRAYNO))
  --! LABELEVENT 'Robot Move to Tray Loading Fixture',2
  MOVE RELATIVE VEC(350,0,0)
  --! LABELEVENT 'Robot Move to Fixture Nest Tray Release',2
  MOVE RELATIVE VEC(0,0,(-350.5+(75.5*TRAYNO)))
  --! LABELEVENT 'Robot Release Tray',4
  OPEN HAND 1
  --! LABELEVENT 'Robot Move to Fixture Clear',2
  MOVE AWAY 75.00
  FULLTRAY=FALSE
END GETEMPTYTRAY

BEGIN
  $USEMAXACCEL=TRUE
  %INCLUDE Robot#
  $MOTYPE=JOINT
  $TERMTYPE=FINE
  $UTOOL = POS(45,0,134,0,-90,0,'')
  DOUT[1]=OFF
  PARTSCOUNT=0
  ROW=1
  COLUMN=1
  FULLTRAY=TRUE
  TRAYNO=0
  MOVE TO HOMEGP
REPEAT
  IF FULLTRAY=TRUE THEN
    GETEMPTYTRAY
    FULLTRAY=FALSE
  ENDIF
```

```
    $MOTYPE=JOINT
    $TERMTYPE=NODECEL
    --! LABELEVENT 'Robot Move Home',2
    MOVE TO HOMEGP
    $TERMTYPE=FINE
    $MOTYPE=JOINT
    --! LABELEVENT 'Robot Move Home Posn',2
    MOVE TO PRESSCLRGP
    PressUnload
    -- Output signal ON, Read by track Press
    DOUT[1]=ON
    -- Delay output reset for .5 secs
    DELAY 500
    DOUT[1]=OFF
    $MOTYPE=JOINT
    $TERMTYPE=NODECEL
    --! LABELEVENT 'Robot Move Home',2
    MOVE TO HOMEGP
    $TERMTYPE=FINE
    MOVE TO PALLETCLRGP
    PalletLoad
    PARTSCOUNT=PARTSCOUNT+1
    IF FULLTRAY=FALSE THEN
      $MOTYPE=JOINT
      $TERMTYPE=NODECEL
      --! LABELEVENT 'Robot Move Home',2
      MOVE TO HOMEGP
    ENDIF
    IF PARTSCOUNT=PARTSTOTAL THEN
      $MOTYPE=JOINT
      $TERMTYPE=FINE
      --! LABELEVENT 'Robot Move Home',2
      MOVE TO HOMEGP
    ENDIF
    --! ENDOFJOB
  UNTIL PARTSCOUNT=PARTSTOTAL
  END Robot
```

c) Open the text editor to view the program track Press.KL. Using the mouse, select the "Press.KL" twice in rapid successions to open the Press.KL track in the program editor.

d) Insert the following changes to the existing Robot.KL track. Do not remove existing comments.

```
PROGRAM Press
--  Workspace LT KAREL 2 Program for MACHINEMOLD Robot
```

```
CONST
  PartsTotal=27

VAR
  PartsCount : INTEGER

  PRESS_UP : AUXPOS
  PRESS_DWN : AUXPOS
  PINS_UP : AUXPOS
  PINS_DWN : AUXPOS

  --! SIGNALDEF DOUT[1],TRACK     -- request robot unload part
  --! SIGNALDEF DIN[1],Robot.KL,1  -- Robot clear press

BEGIN
  $USEMAXACCEL=TRUE
  %INCLUDE Press#
  $MOTYPE=JOINT
  PartsCount=0
  DOUT[1]=OFF
  PartsCount=0
  --! MakeInvisible 1,'PRESSPART'

REPEAT
  --! LABELEVENT 'Press Platen Down',3
  MOVE AUX TO PRESS_DWN
  --! LABELEVENT 'Press Injecting Plastic',5
  Delay 10000
  --! MakeVisible 1,'PRESSPART'
  --! LABELEVENT 'Press Platen Up',3
  MOVE AUX TO PRESS_UP
  --! LABELEVENT 'Press Ejector Pins up',3
  MOVE AUX TO PINS_UP
  DOUT[1]=on
  --! LABELEVENT 'Wait for Robot Clear',3
  WAIT FOR DIN[1]=ON
  DOUT[1]=OFF
  --! LABELEVENT 'Press Ejector Pins Down',3
  MOVE AUX TO PINS_DWN
  PartsCount=PartsCount+1
UNTIL PartsCount=PartsTotal
END Press
```

e) Save the project model .

f) Set throughput options. Using the mouse select Options found on the upper tool bar. From the drop down menu use the mouse to select Throughput Options then select Throughput Settings... . The Throughput Settings menu box will appear. Change "Run time (hours)" to 0.04. Change "Run duration (hours)" to 0.12. Using the mouse select OK .

g) Reload the model before continuing.

h) Using the mouse select (Play simulation) observe the simulation until the end of the simulation run.

i) The Enter name of file for job data pop-up menu will appear. Using the mouse select OK to accept the default values. The "Job_Summary (Read Only).TXT" text editor box will appear. Review the contents and then using the mouse select to close the text editor. The "Robot_Event_Summary (Read Only).TXT" text editor box will appear. Review the contents and then using the mouse select to close the text editor. The "Press_Event_Summary (Read Only).TXT" text editor box will appear. Review the contents and then using the mouse select to close the text editor. The Gant chart of the process will appear. Review the contents and then using the mouse select to close the Gant chart.

j) Reload the model before continuing.

k) From the upper tool bar use the mouse to select Simulate. and then using the mouse again select Run Simulation Blind. Wait for the simulation to end.

l) The Enter name of file for job data pop-up menu will appear. Using the mouse select OK to accept the default values. The "Job_Summary (Read Only).TXT" text editor box will appear. Review the contents and then using the mouse select to close the text editor. The "Robot_Event_Summary (Read Only).TXT" text editor box will appear. Review the contents and then using the mouse select to close the text editor. The "Press_Event_Summary (Read Only).TXT" text editor box will appear. Review the contents and then using the mouse select to close the text editor. The Gant chart of the process will appear. Review the contents and then using the mouse select to close the Gant chart.

m) Reload the model before continuing.

n) Using various $MOTYPE's, $TERMYPE's and $SPEED's commands to achieve a lower cycle time increasing the number of jobs per hour (optimization). Lower speeds and linear motions are required when the EOAT enters a confined space or when approaching other objects. can now be replayed in any Windows compatible media player program.