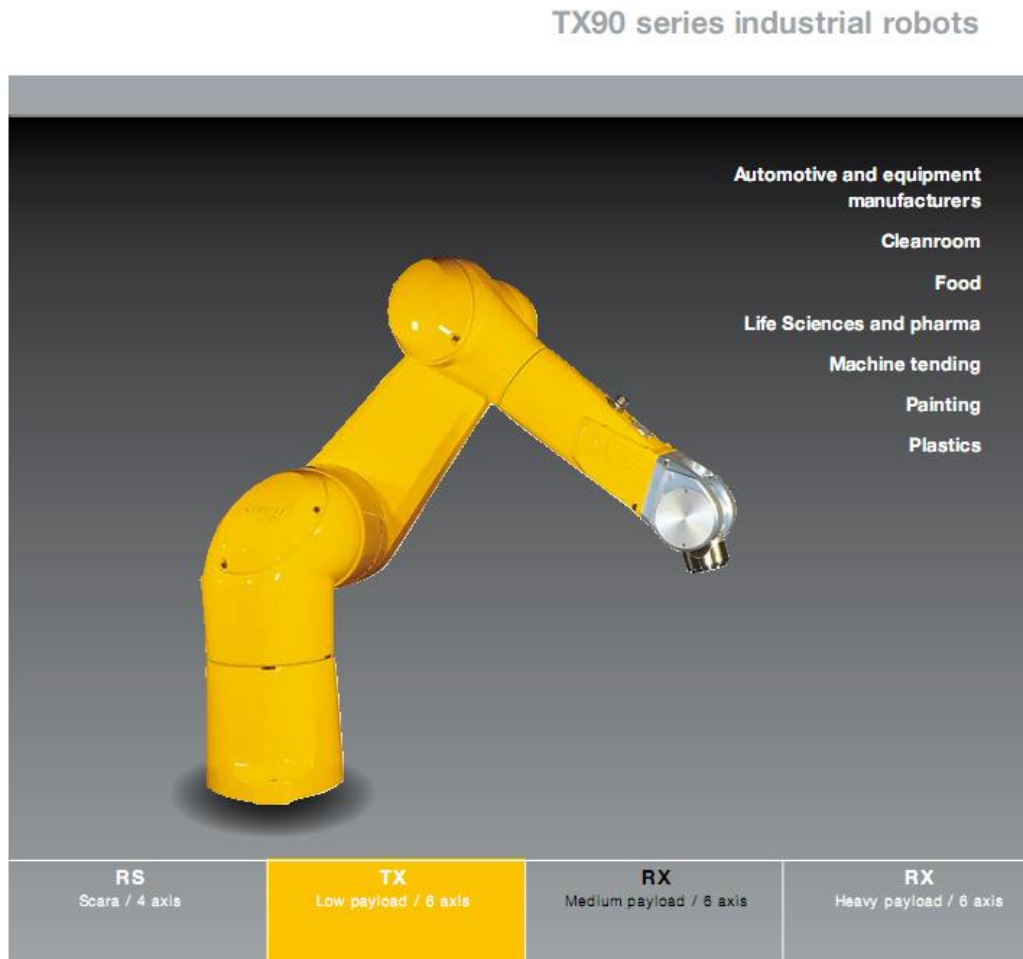
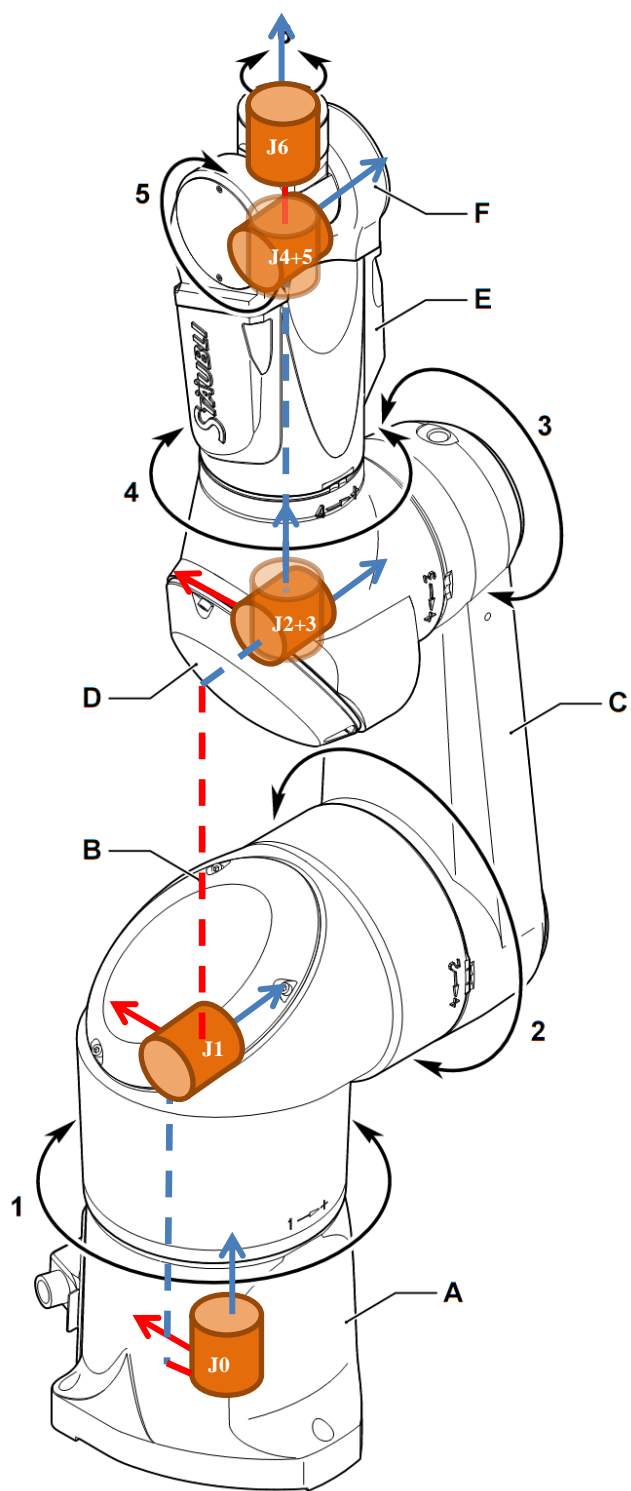


The Following is an articulated arm modeled in MatLab. It is based the TX90 robot, an existing robot produced by Stäubli. The model was acquired though Stäubli website as a Pro-E \*.cad file for demonstration purposes. The file was broken into its seven respective links, exported as a \*.stl file, and imported into MatLab as an array of vectors.



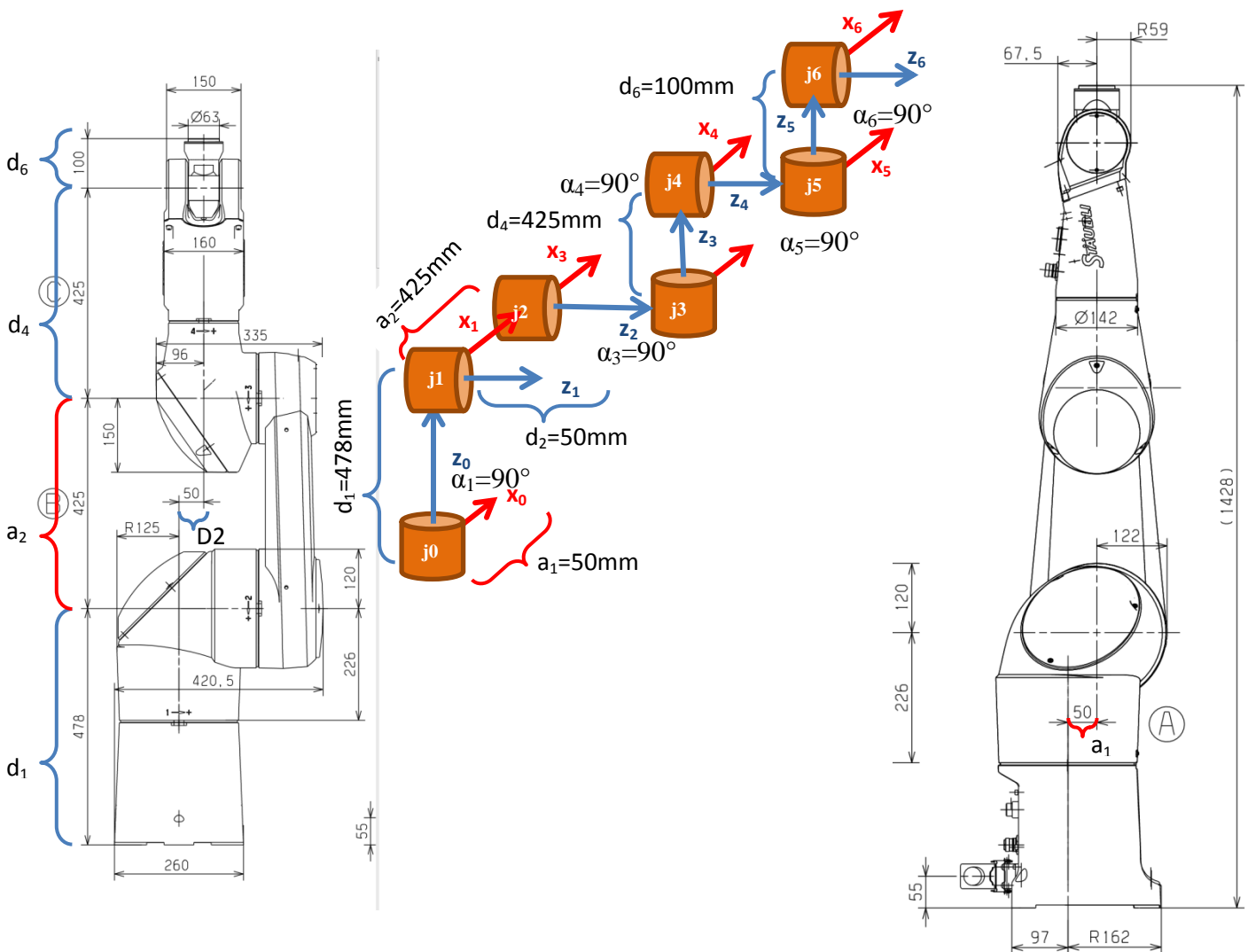
As a note, the use of Stäubli's intellectual property in this project is for educational uses only.

The TX90 is an articulated arm with 6 revolute joints (RRRRRR). The following shows the TX90 with the simplest joint assignment for a DH model.

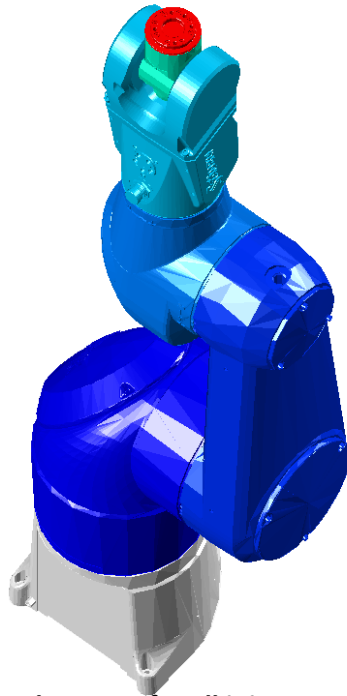
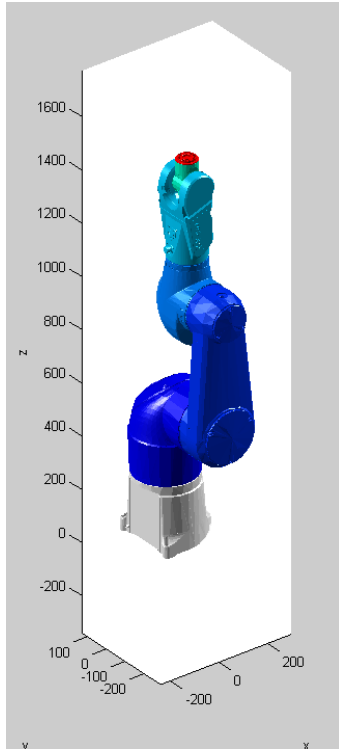


## DH Matrix Table

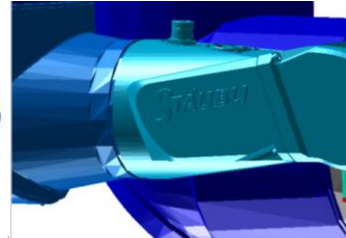
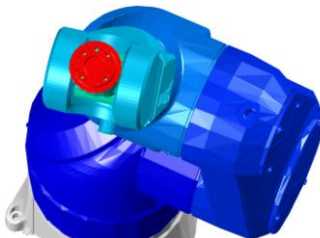
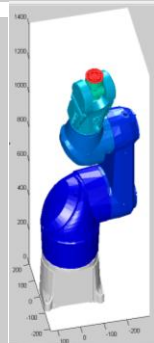
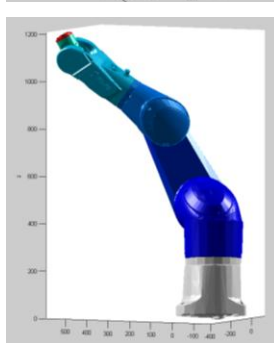
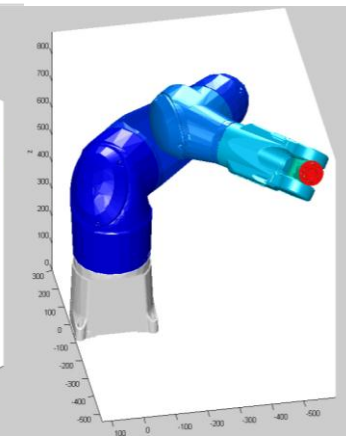
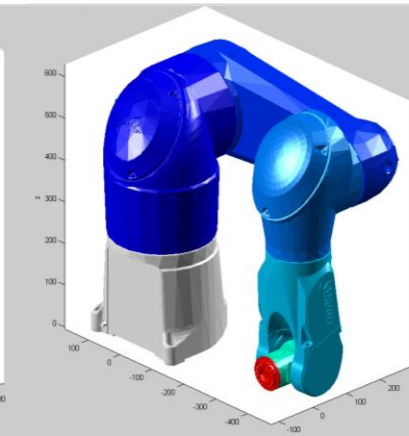
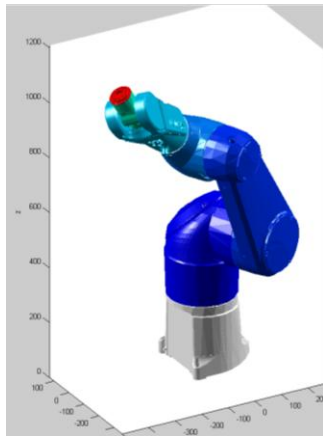
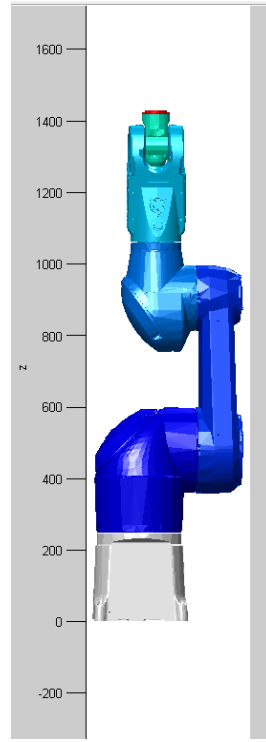
	$\alpha_i$	$a_i$	$d_i$	$\Theta_i$	Transformation
$j_1$ Shoulder	$90^\circ$	50mm	478mm	$\Theta_1$	$T_{01}$
$j_2$ Arm	$0^\circ$	425mm	50mm	$\Theta_2$	$T_{12}$
$j_3$ Elbow	$90^\circ$	0mm	0mm	$\Theta_3$	$T_{21}$
$j_4$ Forearm	$90^\circ$	0mm	425mm	$\Theta_4$	$T_{23}$
$j_5$ Wrist	$90^\circ$	0mm	0mm	$\Theta_5$	$T_{34}$
$j_6$ Tool Flange	$90^\circ$	0mm	100mm	$\Theta_6$	$T_{35}$



Photos of Robot in Motion.



Theta = 0; for all joints



```

%% TX90 Articulated Arm

%% Test stlread
clc
clear all
dtr=0;
%Note, currently all Thetas are equal to 'a':
a=0.0*pi/2;

%% read stl file and set origin

%BASE:j0
base=stlread('TX90base.stl');
base.facecolor=[1,1,1];
base.edgecolor= 'none';
base_origin =[1  0  0  0
               0  1  0  0
               0  0  1  0
               0  0  0  1];
base=transformation(base,base_origin);

%SHOULDER:j1
shoulder=stlread('TX90shoulder.stl');
shoulder.facecolor=[0,0,1];
shoulder.edgecolor= 'none';
shoulder_origin =[1  0  0  -50
                  0  0  1  0
                  0  1  0  0
                  0  0  0  1];
shoulder=transformation(shoulder,shoulder_origin);

%ARM:j2
arm=stlread('TX90arm.stl');
arm.facecolor=[0,.2,1];
arm.edgecolor= 'none';
arm_origin =[0  -1  0  -425
              1  0  0  0
              0  0  1  -50
              0  0  0  1];
arm=transformation(arm,arm_origin);

%ELBOW:j3
elbow=stlread('TX90elbow.stl');
elbow.facecolor=[0,.5,1];
elbow.edgecolor='none';
elbow_origin =[1  0  0  0
               0  0  1  0
               0  -1  0  0
               0  0  0  1];
elbow=transformation(elbow,elbow_origin);

%FOREARM:j4

```

```

forearm=stlread('TX90forearm.stl');
forearm.facecolor=[0,.8,1];
forearm.edgecolor= 'none';
forearm_origin=[-1  0  0  0
                0  0  1 -425
                0  1  0  0
                0  0  0  1];
forearm=transformation(forearm,forearm_origin);

%WRIST:j5
wrist=stlread('TX90wrist.stl');
wrist.facecolor=[0,1,.8];
wrist.edgecolor= 'none';
wrist_origin =[0  1  0  0
               0  0  1  0
               1  0  0  0
               0  0  0  1];
wrist=transformation(wrist,wrist_origin);

%TOOLFLANGE:j6
toolflange=stlread('TX90toolflange.stl');
toolflange.facecolor=[1,0,0];
toolflange.edgecolor= 'none';
toolflange_origin =[1  0  0  0
                   0  0  1  0
                   0  1  0  0
                   0  0  0  1];
toolflange=transformation(toolflange,toolflange_origin);

%% Time based Theta
%for thetal=0*dtr:5*dtr:360*dtr

%% TRANSFORMATION MATRIX

% T = [ 1  0  0  0
%       0  1  0  0
%       0  0  1  0
%       0  0  0  1];

%% Shoulder: j0 to j1
thetal=a;
c1=cos(thetal);
s1=sin(thetal);
T01=[  c1  0  s1  c1*50
      s1  0 -c1  s1*50
      0  1  0  478
      0  0  0  1  ];

%for i=1:1
shoulder_T=transformation(shoulder,T01);

```

```

%% Arm: j1 to j2
theta2=a;
theta2=a+pi/2;
c2=cos(theta2);
s2=sin(theta2);
T12=[ c2  -s2  0  c2*425
      s2   c2  0  s2*425
      0   0  1  50
      0   0  0  1      ];
T02=T01*T12;
% for i=1:1
arm_T = transformation(arm,T02);

%% Elbow: j2 to j3
theta3=a;
theta3=a+pi/2;
c3=cos(theta3);
s3=sin(theta3);
T23=[c3  0  s3  0
      s3  0 -c3  0
      0  1  0  0
      0  0  0  1];
T03=T02*T23;
elbow_T = transformation(elbow,T03);

%% Forearem: j3 to j4
theta4=a;
c4=cos(theta4);
s4=sin(theta4);
T34=[c4  0  s4  0
      s4  0 -c4  0
      0  1  0  425
      0  0  0  1];
T04=T03*T34;
forearm_T = transformation(forearm,T04);

%% Wrist: j4 to j5
theta5=a+pi;
c5=cos(theta5);
s5=sin(theta5);
T45=[c5  0  s5  0
      s5  0 -c5  0
      0  1  0  0
      0  0  0  1];
T05=T04*T45;
wrist_T = transformation(wrist,T05);

%% ToolFlange: j5 to j6

```

```

theta6=a;
c6=cos(theta6);
s6=sin(theta6);
T56=[c6  0  s6  0
      s6  0 -c6  0
      0   1   0  100
      0   0   0   1];
T06=T05*T56;
toolflange_T = transformation(toolflange,T06);
%end

%% patch links and visual output

figure(1)
cla
light('Position',[-3  1 2]);
light('Position',[3 -1 2]);
material shiny

patch(base)
patch(shoulder_T)
patch(arm_T)
patch(elbow_T)
patch(forearm_T)
patch(wrist_T)
patch(toolflange_T)

%axis ([-1000 1000 -1000 1000 -1000 2000 ])
axis equal
view(3)
xlabel('x')
ylabel('y')
zlabel('z')

%pause(.01)

%end

```