Projet WorldSkills : Leipzig 2013

Projet de :
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Métier représenté :
Robotique Mobile

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Remerciements

Nous tenons à saisir cette occasion et adresser nos sincères remerciements et nos profondes reconnaissances à :

- Monsieur Rochdi Merzouki, Mademoiselle Coralie Escande et Monsieur Olivier Scrives, nos encadrants au sein de Polytech'Lille, pour leurs précieux conseils tout au long de notre recherche.

- Monsieur Fabien Delorme, notre expert au sein de Worldskills France, pour ses précieux conseils tout au long de notre recherche.

- Aux responsables et aux personnels de Worlskills France qui par leur compréhension et leur aide, nous ont permis d'accomplir notre travail.

- A nos familles et nos amis qui par leur soutient et leurs encouragements, nous ont permis de surmonter tous les obstacles.

Nous tenons à remercier toute personne qui a participé de prés ou de loin à l'exécution de ce beau projet.

Sommaire

Introduction

Nous avons l'occasion grâce à l'école et la région Nord Pas-de-Calais de participer à une compétition internationale de robotique qui se déroulera du 2 au 7 Juillet 2013 à Leipzig, en Allemagne. Nous serons ainsi les premiers candidats français de la **WordSkills competition** dans le métier de robotique mobile. Ce projet d'IMA4 est pour nous l'opportunité de se préparer à cette compétition.

Nous allons présenter la compétition de manière générale puis de manière spécifique à notre métier. En ce qui concerne la partie spécifique au métier nous présenterons les deux épreuves de la compétition, notre stratégie pour les réaliser et nos moyens mis en œuvre pour la tester

I. Le contexte de la compétition

A. Présentation de WorldSkills

Les Olympiades des Métiers, ou WorldSkills compétition, permettent aux meilleurs jeunes professionnels du monde entier de se mesurer lors d'une compétition internationale, organisée sur un même site, donnant ainsi une vision globale et concrète des métiers et compétences d'aujourd'hui dans tous les secteurs de l'économie. Chaque pays peut sélectionner un candidat dans les métiers retenus pour le concours international. Pour qu'un métier soit retenu pour la compétition, il faut que 12 pays au moins présentent un candidat.

Organisées tous les 2 ans dans un pays du monde par WorldSkills international, les Olympiades des Métiers reposent sur la volonté de « promouvoir les métiers et convaincre partout à travers le monde qu'ils apportent une contribution essentielle au succès économique des pays et à l'accomplissement personnel des individus », charte de WorldSkills international, qui compte aujourd'hui 63 pays dont la France.

« ***WorldSkills est une structure forte permettant de construire une culture internationale de respect des compétences. Cette organisation permet aux meilleurs jeunes professionnels du monde de motiver et d'inspirer les générations futures afin qu'elles comprennent que la formation professionnelle peut apporter un niveau de vie sûr et un réel épanouissement dans un monde concurrentiel et en constante mutation*** »

Simon BARTLEY, Président de Worldskills International

B. Préparation avec WorldSkills France

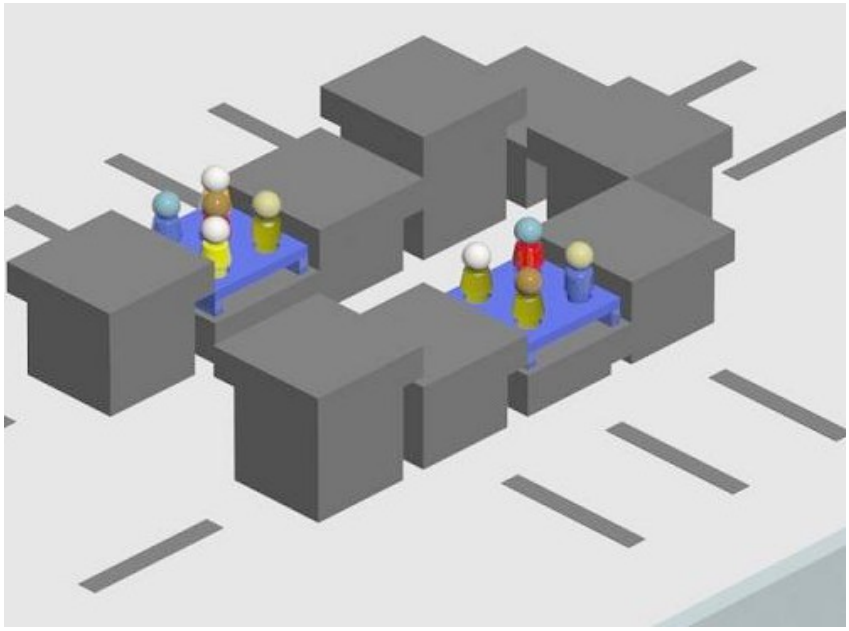
Tout au long de notre préparation pour le concours Worldskills, nous avons été épaulés par :

- Worldskills France : qui nous a fourni des équipements et une préparation à la fois Physique, Mentale et Technique
- Fabien Delorme : qui est notre expert pour la compétition et qui nous permet de garder un contact permanent avec les organisateurs de la compétition
- Polytech'Lille : qui nous a alloué du temps de préparation technique, des locaux pour nous entrainer dans de bonnes conditions et des professeurs chercheurs pour nous aider en cas de problème.

II. Les épreuves

A. Lost in the Black Forest

L'épreuve cherche à simuler le quadrillage d'une zone par un robot pour qu'il puisse aider des équipes de recherche à retrouver des personnes perdues. Il y a donc 48 « arbres » qui sont placés sur la piste (se sont en réalité des socles), les arbres ont des hauteurs différentes, 9 palettes avec des « enfants perdus » seront disposés aléatoirement sur les 48 socles (Palette avec 4 ou 5 bonhomme FischerPrice)



Les points que nous avons le plus travaillés pour cette épreuve sont :

- La stratégie pour contrôler le robot sur la piste
- Le contrôle du Lève Palette avec mise en place d'un asservissement
- Le traitement d'image

A.1. La stratégie

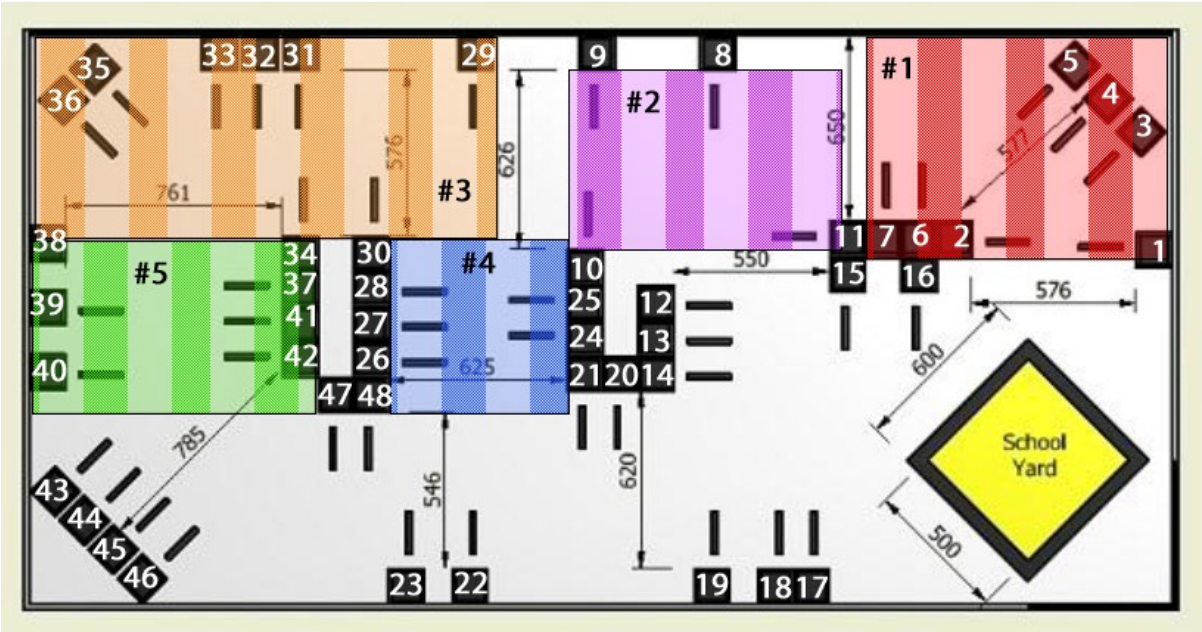
Le but de l'épreuve est de ramener tous les bonhommes avec une durée maximale de 15 minutes d'évaluation. Il faut donc aller le plus vite possible. Nous avons donc choisi un algorithme qui va passer devant chaque arbre une seule fois. Il nous faut donc un moyen de cartographier la piste pour pouvoir aller au point de départ lorsque l'on trouve des enfants perdus, mais il faut également être capable de retourner au dernier point contrôlé sans entrer en collision avec les autres arbres.

Pour cela, nous avons choisi de cartographier la carte comme ceci :

1. Numérotation de tous les arbres de 1 à 48
2. Découpage de la piste en 6 zones
    1. Rouge
    2. Violet

3. Orange
4. Bleue
5. Verte
6. Blanche

Voir image ci-après :



Pour chacune des zones nous avons définit des points intermédiaires par lesquels le robot doit passer pour éviter toute collision.

A ce stade, notre robot est capable de se repérer sur la carte, il doit maintenant être capable de détecter la présence d'objet et attraper la palette.

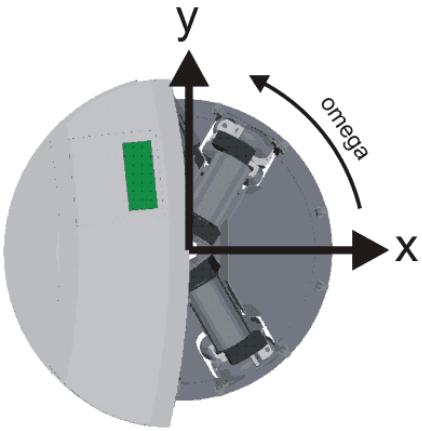
Dans les deux cas, nous allons utiliser la caméra, pour détecter la présence ou l'absence d'une palette. Le cahier des charges nous informe que les palettes et les socles sont de couleurs différentes, ainsi il suffit de chercher la couleur souhaitée pour attester de la présence ou de l'absence de palette. Ensuite pour attraper la palette, on peut asservir la position du lève-palette en fonction de la webcam.

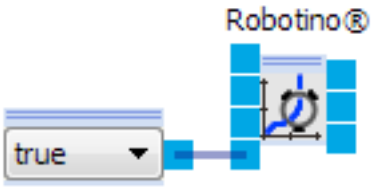
A.2. Réalisation technique

La réalisation technique s'avère être plus compliquée que la théorie, en effet en théorie c'est très simple, mais la mise en pratique est parfois compliquée :

A.2.a) L'odométrie

L'odométrie permettant de se repérer est très sensible aux variations de la position initiale, en effet lorsque l'on initialise l'odométre, le robot créé un repère virtuel comme sur l'image si dessous



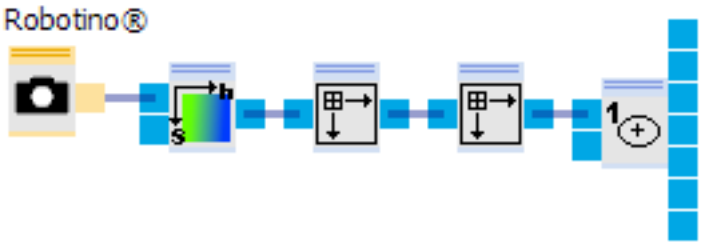


Il faut donc faire attention à l'angle de départ du robot sinon tout le repère se retrouve tourné, et tous les points sont alors décalés.

A.2.b) Détection d'objet

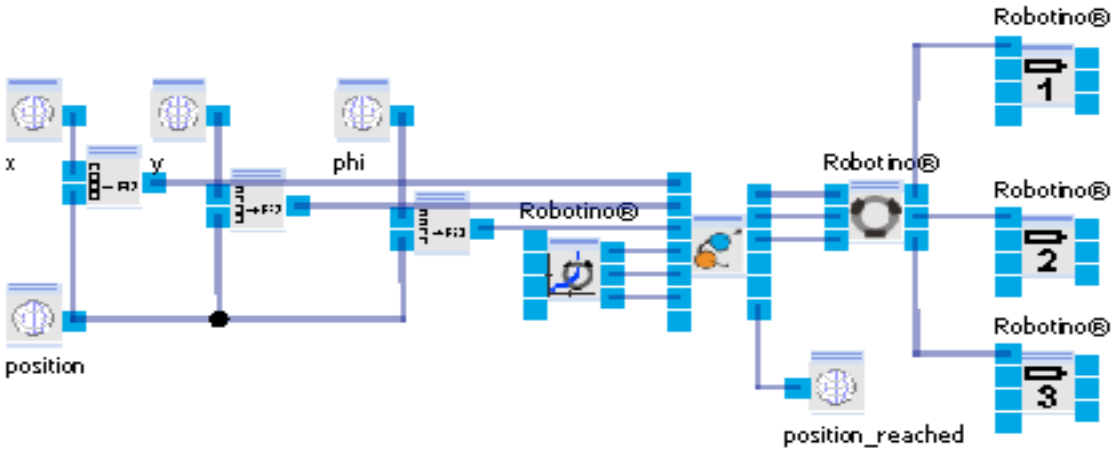
Ensuite pour la détection d'image nous utilisons une petite caméra, RobotinoView permet de faire du traitement d'image simple avec des filtres :

- Le filtre colorimétrique permet d'isoler une plage de couleur que l'on sélectionne à l'écran. Il faut toutefois faire attention car la luminosité dans la pièce est très importante, en effet, une variation de lumière due à un nuage peut fausser la mesure.
- nous avons choisit d'utiliser deux filtres en série pour ne détecter que les gros objets de la couleur précédemment sélectionnée, les parasites sont ainsi filtrés.
- Le traqueur de segment permet d'obtenir des informations sur la position de l'objet détecté sur l'image



A.2.c) Déplacement du robot

Pour déplacer le robot nous avons choisi d'utiliser des tableaux dans lesquels sont stockées toutes les valeurs que le robot devra parcourir. Un bloc dans RobotinoView se charge de l'asservissement, il est alors possible de changer les valeurs des vitesses et accélérations de façon à obtenir le mouvement désiré. Il est également possible de choisir si l'on souhaite des mouvements holonomes ou non.



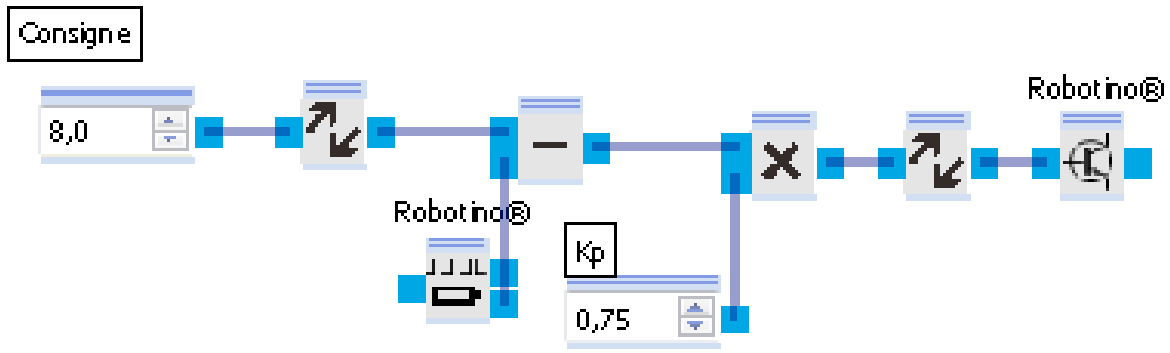
Nous avons sur l'image si dessus utilisé des tableaux x, y, phi. L'indice du tableau est le chiffre position. Enfin lorsque la position est atteinte, on passe position_reached à vrai. Ensuite la valeur de position sera incrémentée par un bloc pour pouvoir passer à la position suivante.

A.2.d) Contrôle du lève-palette

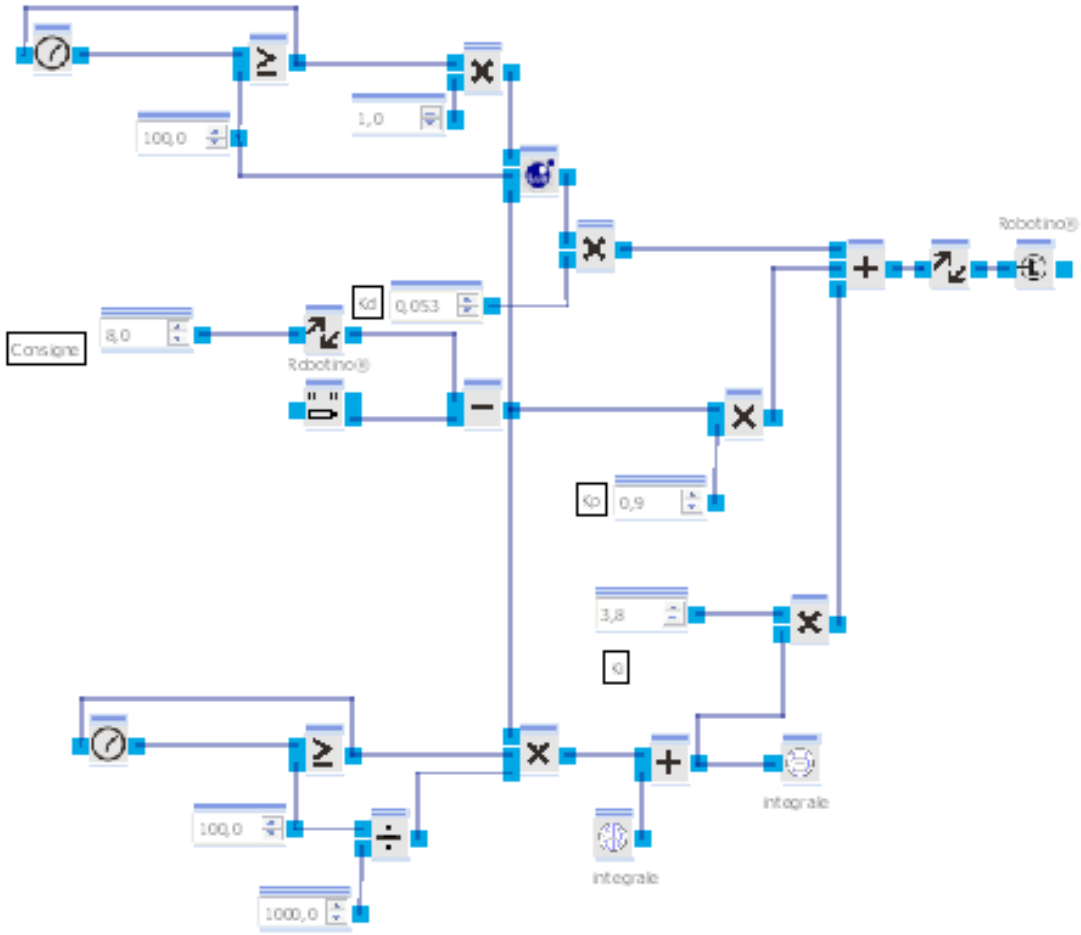
Le Robotino est équipé d'une « sortie de puissance », cette dernière permet de connecter un moteur Festo supplémentaire. Cependant aucun bloc n'est prédéfini pour l'asservissement. Nous allons donc utiliser une fonction de transfert pour gérer la commande en vitesse de la sortie de puissance. L'asservissement est fait sur la position, mais la pince est commandée en vitesse.

Pour améliorer les performances, nous avons essayé d'ajouter un correcteur. Dans un premier temps, nous avons mis un correcteur proportionnel, puis un correcteur PI et enfin un correcteur PID, en utilisant la méthode Ziegler-Nichols. Cependant après de multiples tests, nous nous sommes rendu compte que les performances avec les correcteurs PI et PID ne sont pas significativement meilleures. Nous avons choisi d'utiliser un correcteur proportionnel car il est plus rapide à mettre en place, et que le jour de la compétition, nous aurons besoin d'être rapide. De plus, la précision est pratiquement la même entre les différents correcteurs, enfin la dérivée et l'intégral ne sont pas directement donnée par RobotinoView, il faut donc les programmer à l'aide d'un bloc permettant d'écrire des scripts en langage Lua.

Voici le correcteur proportionnel :



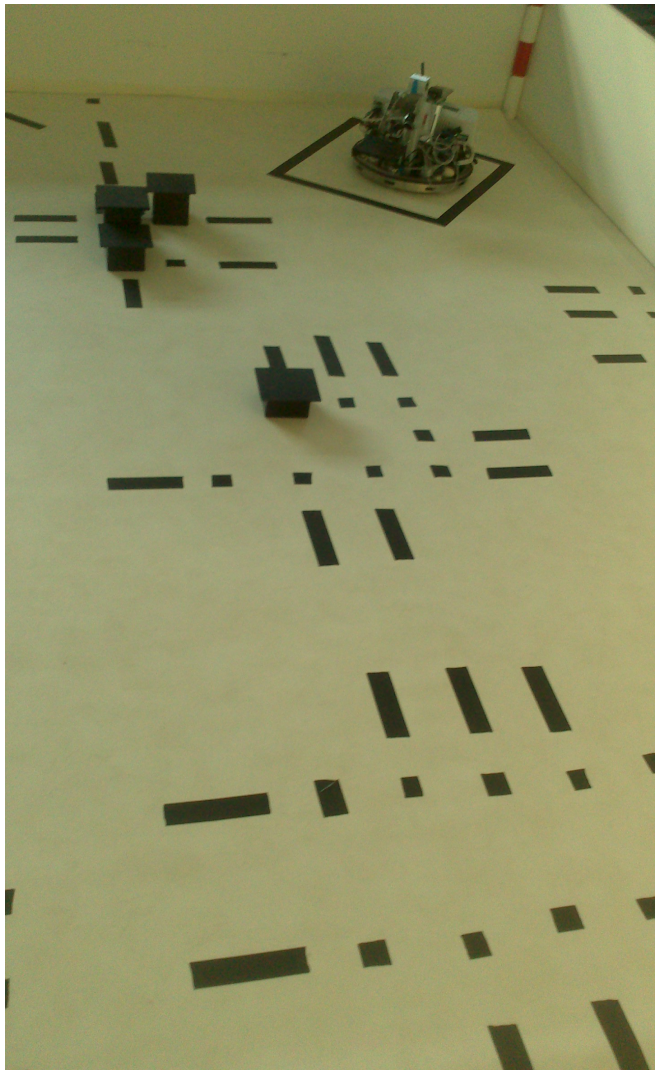
Voici le correcteur PID :



A.3. Tests

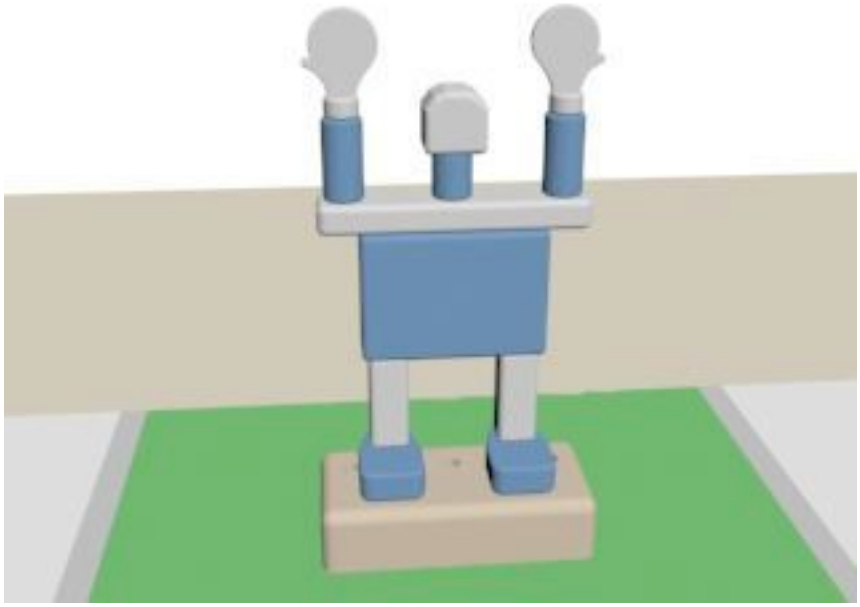
Afin de pouvoir tester notre stratégie, nous avons décidé de réaliser la piste de l'épreuve à l'échelle réelle telle qu'elle sera le jour de la compétition. Nous avons également réalisé une palette et quelques supports (un par taille différente possible).

Voici la piste que nous avons réalisée avec les plots et la palette positionné sur le robot.



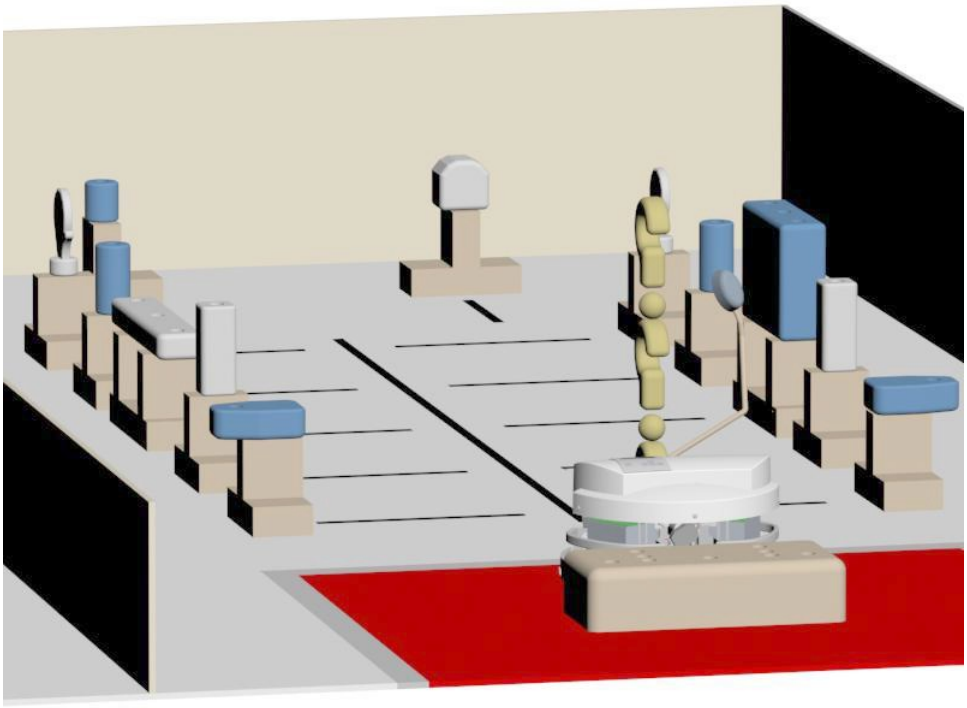
B. Made in Germany

Pour cette épreuve, il nous est demandé de construire une extension pour le Robotino, la pince peut avoir la forme que l'on souhaite, il n'y a aucune restriction.
Notre Robotino, avec cette extension, devra construire un bonhomme, il doit aller chercher les pièces une à une des pieds à la tête et les assembler.



B.1. La stratégie

Lors de cette épreuve, la difficulté n'est pas le déplacement du robot, mais l'assemblage des pièces et la conception de la pince. En effet, de nombreuses lignes sont posées au sol pour guider le robot jusqu'aux différents objets à assembler.



Étant donné que le Robotino est équipé d'une quatrième connectique pour brancher un moteur supplémentaire, nous avons décidé de motoriser notre pince à l'aide de moteurs commercialisés par Festo.

Notre pince est constituée de :

- une glissière d'une hauteur de 80cm qui permet de monter et de descendre une mâchoire verticalement
- une mâchoire qui permet d'attraper les pièces

Chacune de ces deux parties est motorisées à l'aide des moteurs Festo. Pour avoir une compatibilité direct avec le robot.

Dans cette partie, les objets sont toujours placés au même endroit, nous allons donc programmer le robot de façon à ce qu'il aille chercher les pièces une par une et qu'il les assemble au bon endroit.

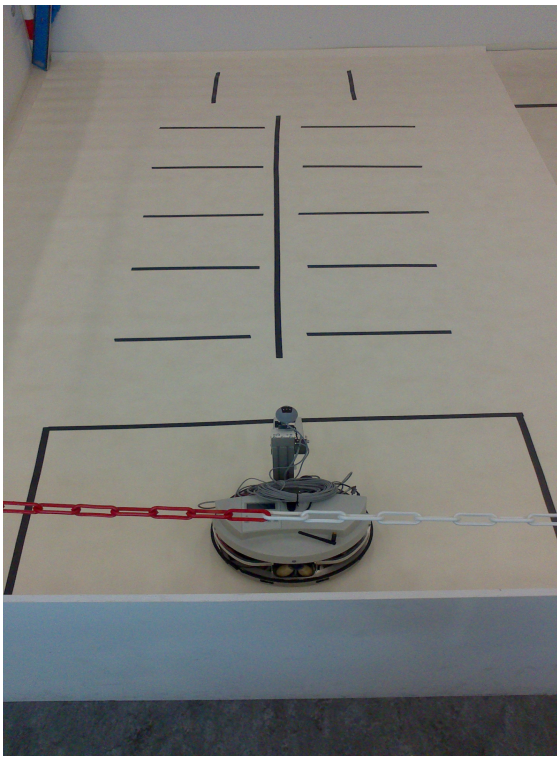
B.2. Réalisation technique

Pour la réalisation technique de la pince, nous avons rédigé un cahier des charges fonctionnels à destination du département mécanique de Polytech'Lille. La pince devrait alors être livrée assez rapidement, mais nous n'avons pas de date exacte.

B.3. Tests

Afin de pouvoir tester l'extension, nous avons réalisé la piste sur laquelle le robot devra évoluer, ainsi que quelques parties du robot.

Voici une photo de la piste que nous avons réalisée :



Conclusion

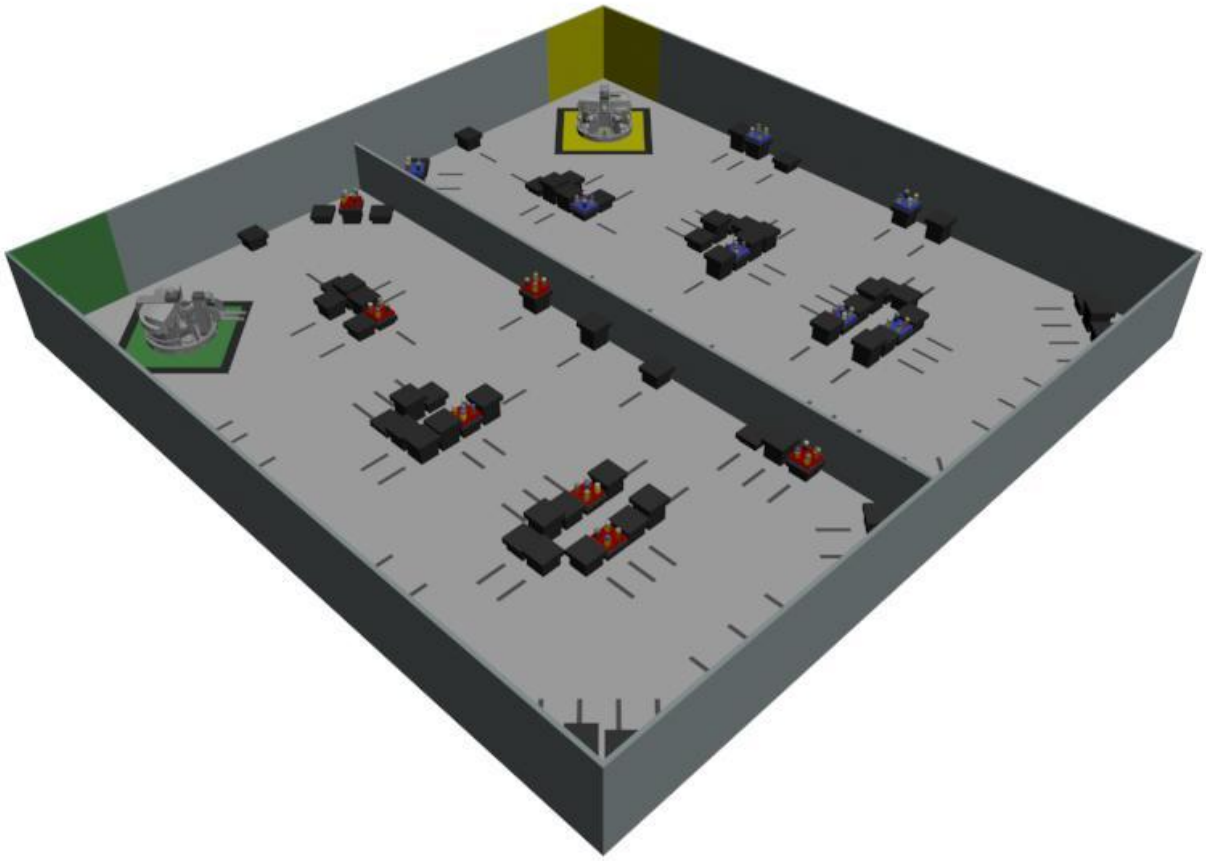
Durant ce projet, nous nous sommes donc préparés pour la compétition en réfléchissant à la meilleure stratégie pour chaque épreuve et en s'entraînant à les réaliser sur les pistes aux dimensions réelles.

Cependant, pour nous si le projet s'arrête ici, la préparation n'est pas terminée. Il nous reste deux mois jusqu'au début de la compétition et encore beaucoup à faire.

ANNEXES

Annexe 1 : Règlement de l'épreuve **Lost In The Black Forest**
Annexe 2 : Règlement de l'épreuve **Made In Germany**

DRAFT
Test Project Proposal: Lost in the Black Forest : Forklift Version
WSC2013_TP23_AA_EN



Submitted by:
Name: Bob Tone, 2013 Mobile Robotics Expert
Member Country: Canada

INTRODUCTION

The **'Lost in the Black Forest'** task requires competitors to:

- Manage the Mobility and Autonomous Object Management System of a 'School Yard Monitor Robot'
- Children (Small Disks) have left the school yard to play in the trees of the Black Forest. The School Yard Monitor Robot must bring these Children (Small Disks' back to the school yard.

CONTENTS

This Test Project Proposal consists of the following documentation / files:

DESCRIPTION OF PROJECT AND TASKS

The Two Lost in the Black Forest Courts each provide:

- Two Side by Side **Independent School Yard / Black Forest Environments**
- The Children in the Green School Yard are Positioned in Trees On **RED Child Carriers**
- The Children in the Yellow School Yard are Positioned in Trees On **Blue Child Carriers**
- 5 to 6 Teams of Competitors are expected to share the pair Independent School Yard / Black Forest Environments in each court during the 'Daily AM Shared Court Access Open Work Periods'
- All Teams of Competitors can expect to have 'Evaluation Task Runs' in BOTH of the Independent School Yard / Black Forest Environments present in their Assigned Court and will need to prepare to retrieve BOTH **RED** and **Blue Child Carriers**.

Note:

- Competitors should consider that the Black Forest Environment shown on the cover page of this document represents the most difficult (number and type of trees) Black Forest Pattern possible.
- The Competition Leipzig Black Forest Patterns will be set by the Mobile Robotics Expert Jury Panel based on the options presented in this document.

This task is designed to have use of the Laser Scanner as an available to the Competitors option.

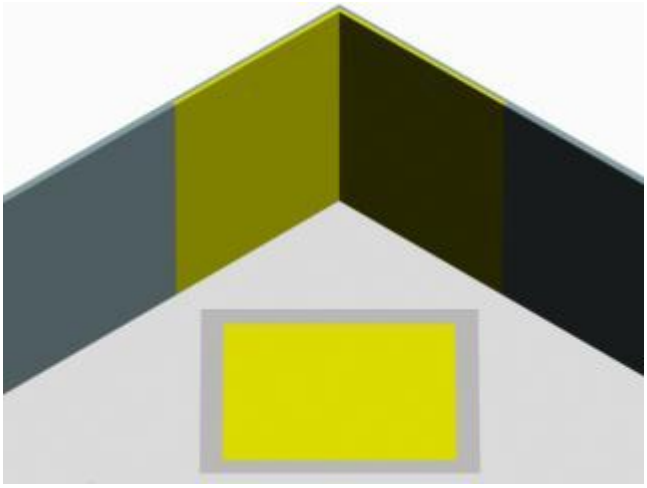
- A Laser Scanner placed On Top of the Robot and aligned with the Robot's Centre extends a Horizontal Laser Beam out that is approximately 26 to 28 cm's above the court floor.
- The court conditions above support the Laser Scanner maintaining constant contact with the Four Walls of the Independent School Yard / Black Forest Environment in which it is operating.
- The Centre Court Divider is 30 cm tall.
- The Black Forest Trees are 5,7,9,11 and 13 cm tall
- The Children are Standard Fisher Price Children

- The Child Carriers are 110 by 110 by 25 mm with an Under the Carrier Open Space of 110 by 90 by 15 mm
- The Child Pockets in the Carriers will be either 3 mm or 5 mm Deep and have a Dia. 2mm Greater than a Standard Fisher Price Child's Base.

  Note: The Expert Jury Panel will determine the Child Pocket Depth during the Task Approval Voting Process.

Independent School Yard / Black Forest Environment Elements

The School Yard



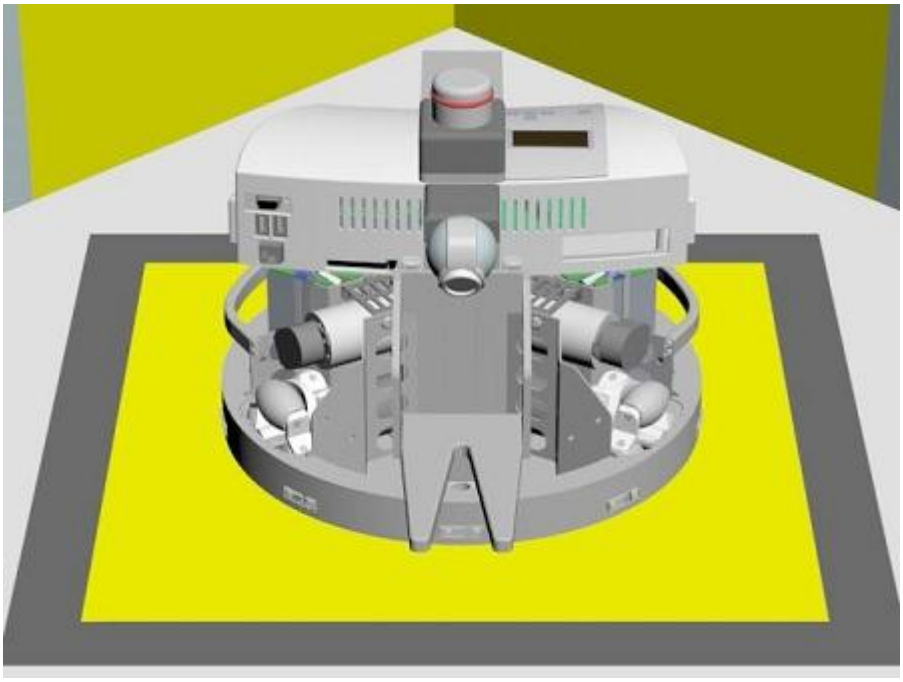
The School Yard Area is a 500 by 500 mm space.

This area includes a 50 mm Tape Line all around the School Yard Perimeter.

The School Yard Area will be either a Green or a Yellow Vinyl Sheet.

The Court Corner Walls will have either Green or Yellow vinyl sheets representing the Green and Yellow Schools.

The Robot Start Position

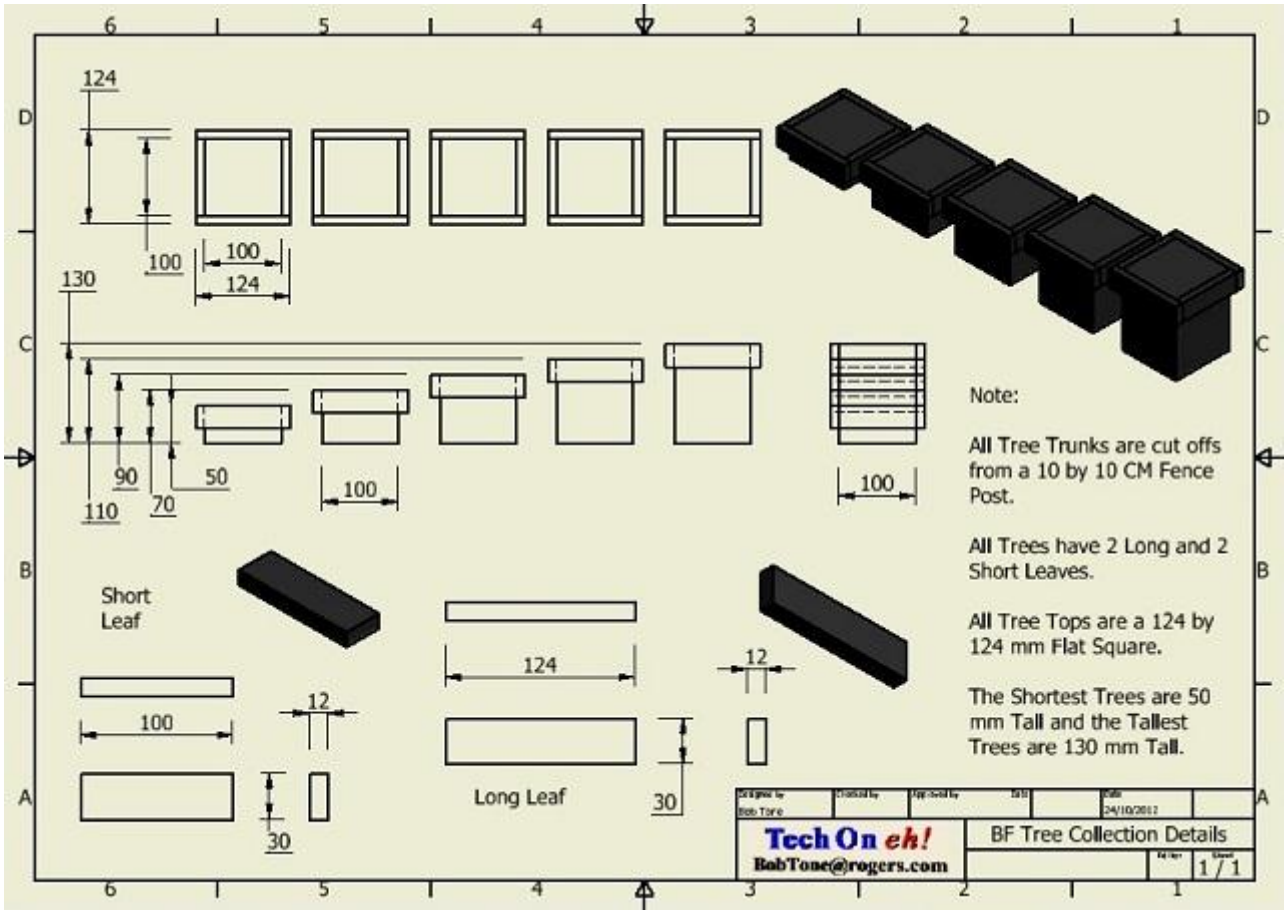


Robots start in the School Yard Areas directly in front of the schools.

The Robot MUST be 100% Inside the School Yard Fence (Tape Line).

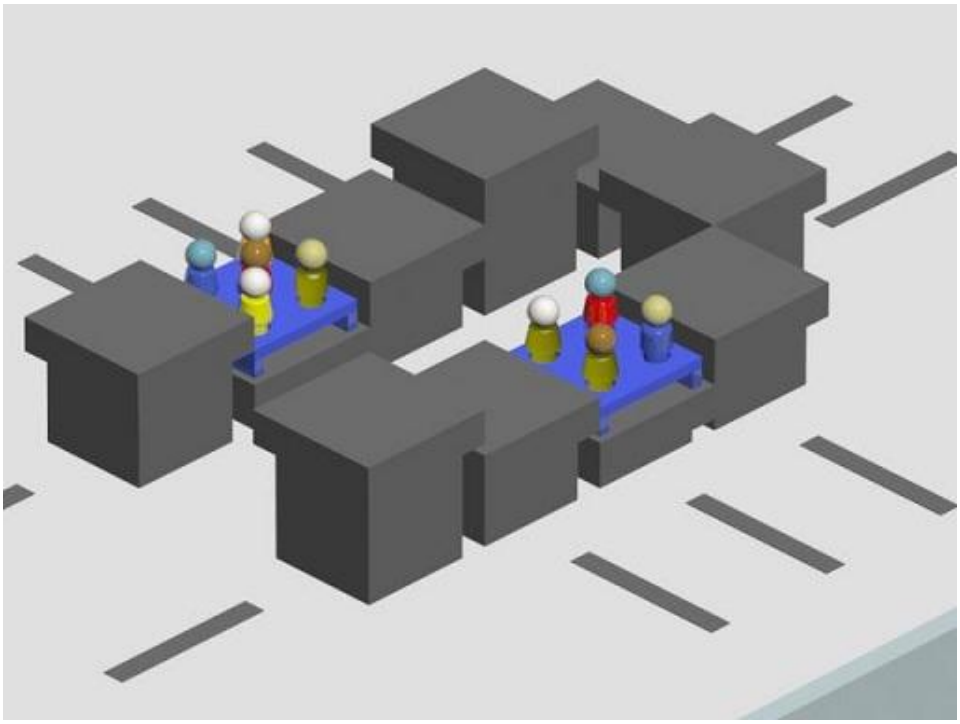
The Start of the Task Robot Orientation is a Competitor Decision.

Black Forest Environment / The Black Forest Trees



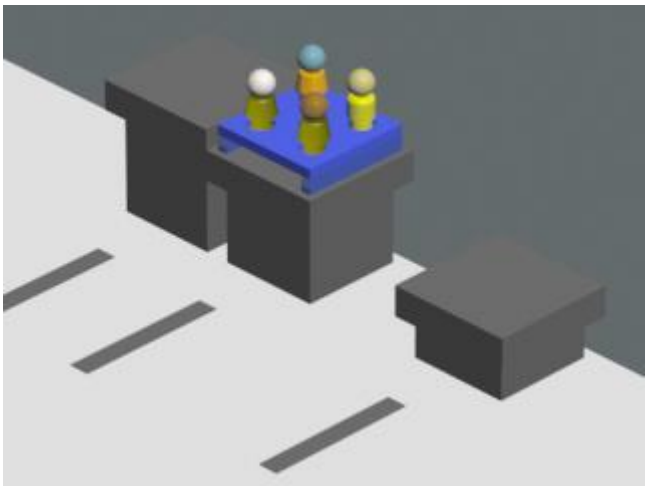
Placement of Children in the Trees

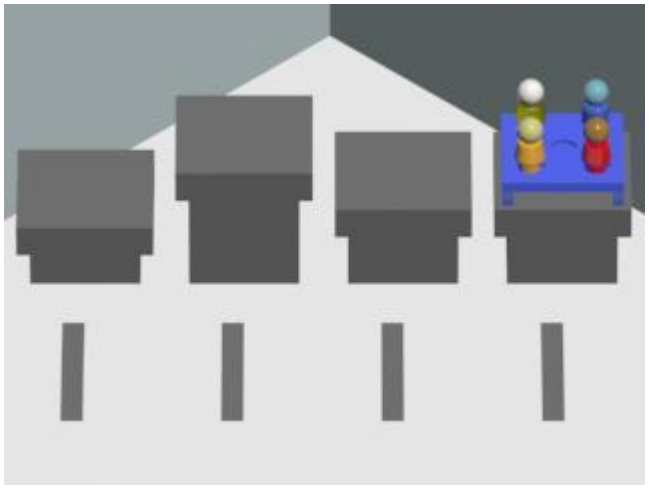
- In the Pockets of Child Carriers Only
- Child Carriers will always be placed in the Centre of the Tree Top
- ALL Trees will have a 25 cm long Tape Line positioned 5 cm in front of the tree
- One edge of the Tape Line will be aligned with the Centre Point of the Tree

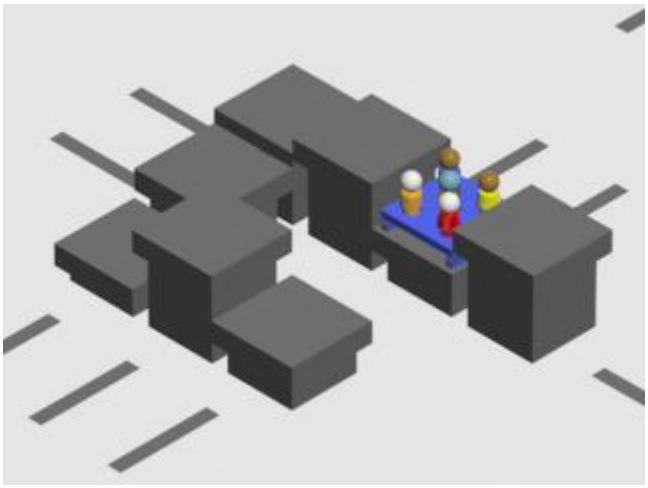


The Black Forest

- Trees will be placed in the Black Forest as Individual Stand Alone Trees and as Clusters of Trees involving various numbers of Trees in each Cluster.
- The Majority of Trees will have NO Children in them.
- All Forest Paths the Robot is expected to travel along will provide a Minimum Opening of 50 cms.
- The Competition Forest Patterns will be set by the Mobile Robotics Expert Jury Panel in Leipzig.







Marking

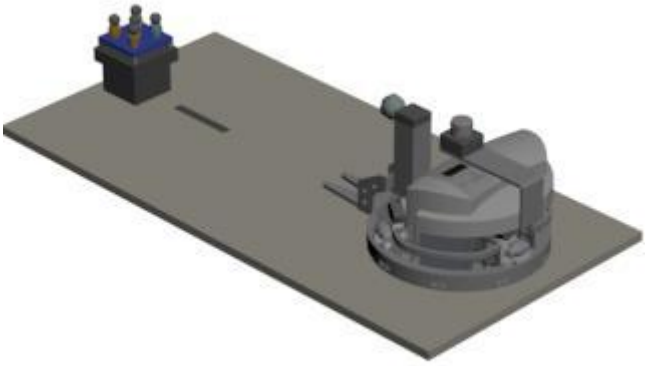
Marking will take place in two stages.

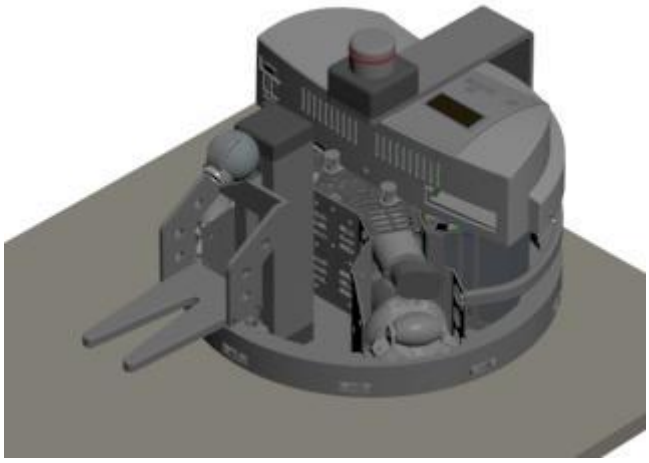
Stage One: Isolated Autonomous Object Management involving the Forklift / Child Carriers / a Variety of Trees with the Forklift Object Management / Robot Minimal Mobility Performance being marked in each Team's own Workspace. Value 40% of the Overall Mark

- Teams will have a Robot Performance Testing / Practice Space in their Assigned Workspace.
- Autonomous Object Management Marking will take place during the AM Competition Sessions.
- Autonomous Object Management Marking will take place on the Robot Testing / Practice Space in each Team's own Practice Child Carriers / Trees.

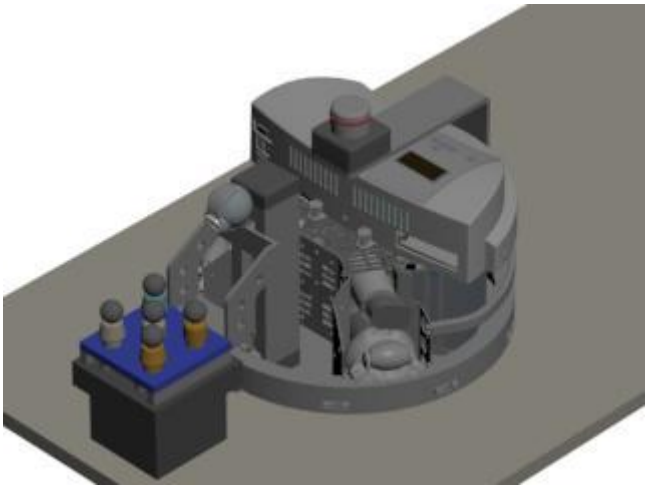
Note: If the Competitor provided items are deemed to not be incompliance with the Competition Standard then an alternate set of Testing Elements will be provided and used for the CBRCOMS Performance Specific Marking Process.

Forklift Object Management / Robot Minimal Mobility Performance Marking Sample

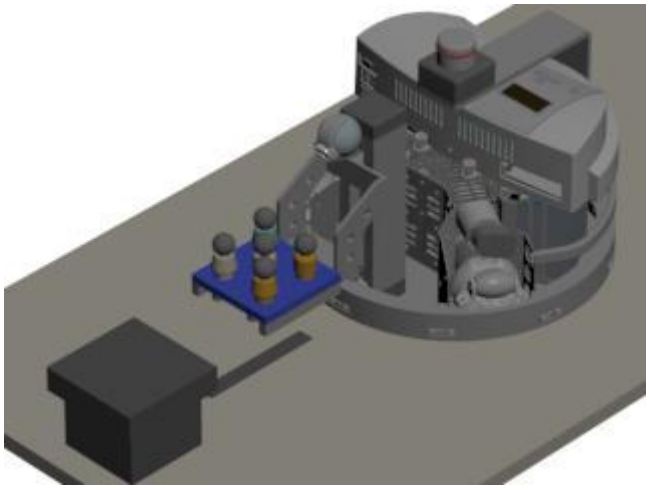




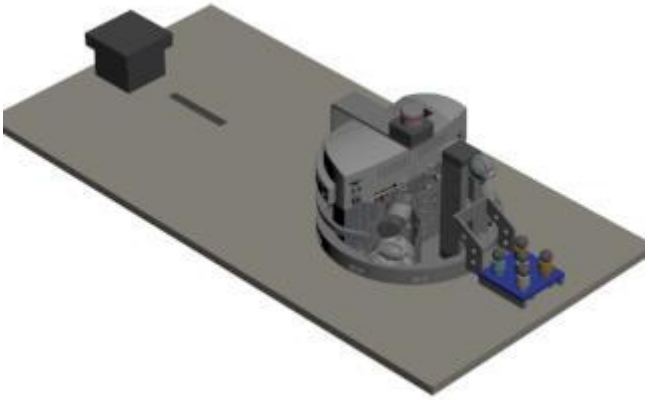
Robot Positioned Directly Opposite a Tree with a Child Carrier On the Tree Top



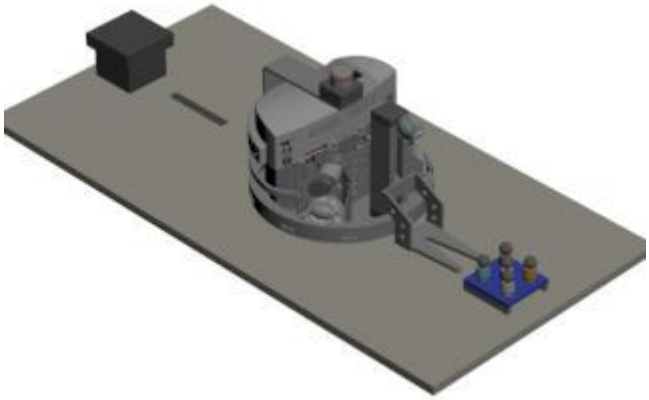
Robot Moves Forward and Positions the Forklift Under the Child Carrier



Robot lifts the Child Carrier Off the Tree and moves away from the Tree.



Robot Turns 180 Degrees and Travels to the End of the Practice Space



Robot Places the Child Carrier on the Practice Surface and backs away clear of the Child Carrier

Stage Two: On the Court School Yard Monitor Robot Complete Task Performance. Value 40% of the Overall Mark

Marking

- All Marking will take place **AFTER an Evaluation Task Run has been COMPLETED**.
- The Mark Value on a Per Child Carrier and Child Basis will depend on the Number of Child Carriers and Children in the Black Forest and the Overall Number of Evaluation Task Runs available per Task.
- 70 % of each Evaluation Task Run's Marks will be awarded based on the Number of Child Carriers returned to the School Yard.
- 20 % of each Evaluation Task Run's Marks will be awarded based on the Number of Children returned to the School Yard.
- 10 % of each Evaluation Task Run's Marks will be awarded based on the Time Taken to Return a Complete Set of Child Carriers and Children to the School Yard.

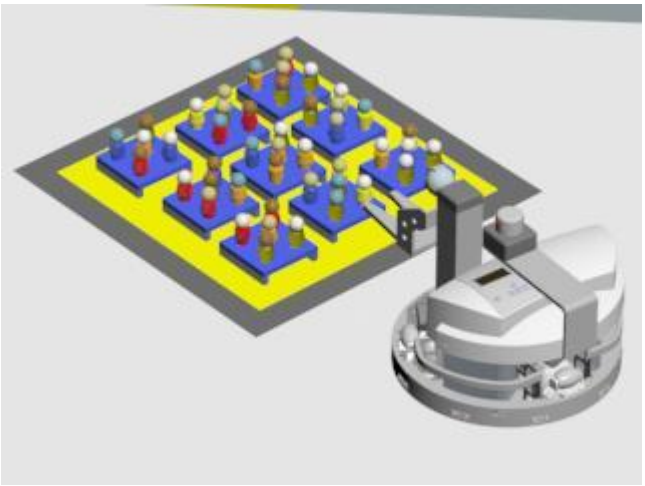
  Note: Time Marks will be calculated in the CIS based on the following formula: Overall Best Qualified Team Task Run Time / Individual Team's Qualified Time X Total Individual Task Run Time Marks available

Note: The Number of Time Marks available per Task Run will depend on how many Evaluation Task Runs can be scheduled per Team.

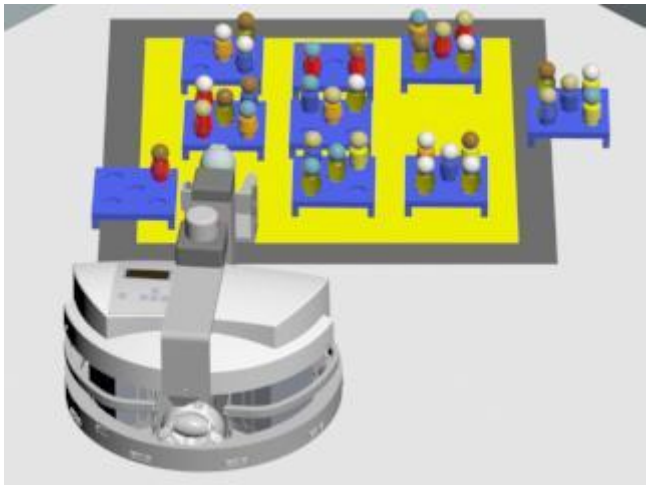
Child Carriers and Children must be 100% in the School Yard to for a Team to be awarded a mark.

The sample to the right displays a Perfect Task Completion Result in the Maximum Difficulty (9 Child Carriers and 45 Children) Task Pattern.

ALL 9 Child Carriers and 45 Children have been successfully returned to the School Yard and this Team would qualify for a Time Mark.



The sample to the right displays a Partial Task Completion Result in the Maximum Difficulty (9 Child Carriers and 45 Children) Task Pattern.



Marks are awarded for:

- 7 Child Carriers 100% in the School Yard
- 28 Children in the School Yard

Marks are NOT awarded for:

- 1 Child Carrier 100% Outside the School Yard
- 5 Children On a Child Carrier but Outside the School Yard
- 1 Child Carrier only Partially in the School Yard
- 12 Children who have Fallen Off the Child Carriers

This Team would NOT qualify for a Time Mark.

INSTRUCTIONS TO THE COMPETITOR

Competitors are expected to demonstrate True Fair Play and Co-operation at all times but most particularly when they are sharing the court spaces during the AM Work Periods.

Given the Child Carriers in the Side by Side Black Forests are Different Colours (**Red** and **Blue**) Competitors can use Camera Based Colour Analysis to locate Children in the Black Forest.

Competitors must prepare to have Task Evaluation Runs in BOTH sides of the Black Forest Court.

EQUIPMENT, MACHINERY, INSTALLATIONS AND MATERIALS REQUIRED

Competitors are responsible to bring to the competition site and to use exclusively during the competition the Robot provided to them 6 months prior to the competition for use during their competition preparation activities.

Competitors are expected to bring ALL of their Competition Equipment in a container no larger than One Cubic Meter.

The Forklift, Laser Scanner and Camera Image Management are the focus of this Task.

MARKING SCHEME

Marking is based on **Four Criterion**:

Criterion One: Forklift Management in the Workspace. Value 40%

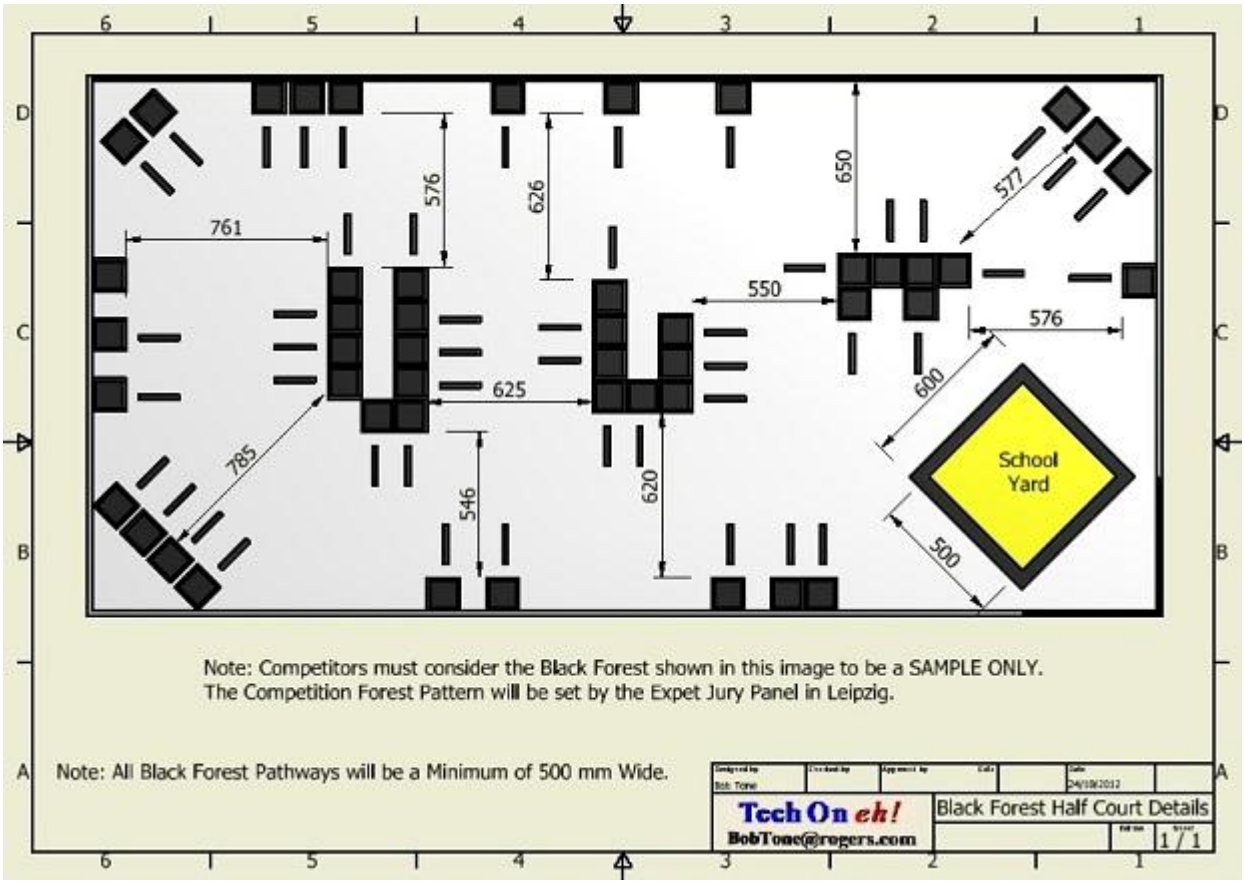
On the court Performance Value 60%

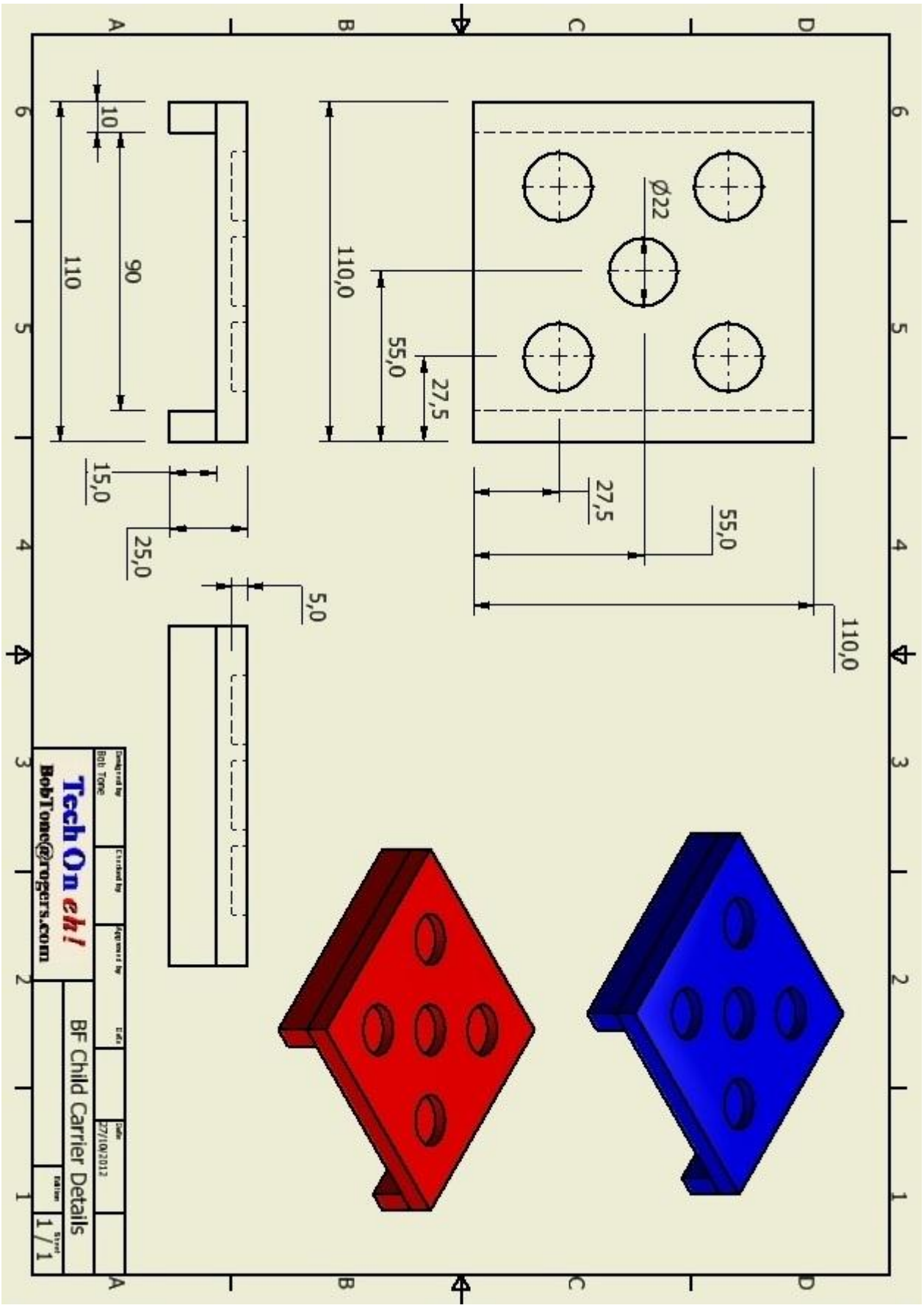
Criterion Two: Delivery of Child Carriers to the Designated School Yard Area. Value 70% of the Marks available per Evaluation Task Run.

Criterion Three: Delivery of Children to the Designated School Yard Area. Value 20% of the Marks available per Evaluation Task Run.

Criterion Four: Time Mark (Awarded only if Criterions 1 and 2 have been completed 100%) Value 10% of the Marks available per Evaluation Task Run.

Sample Black Forest Court Layout

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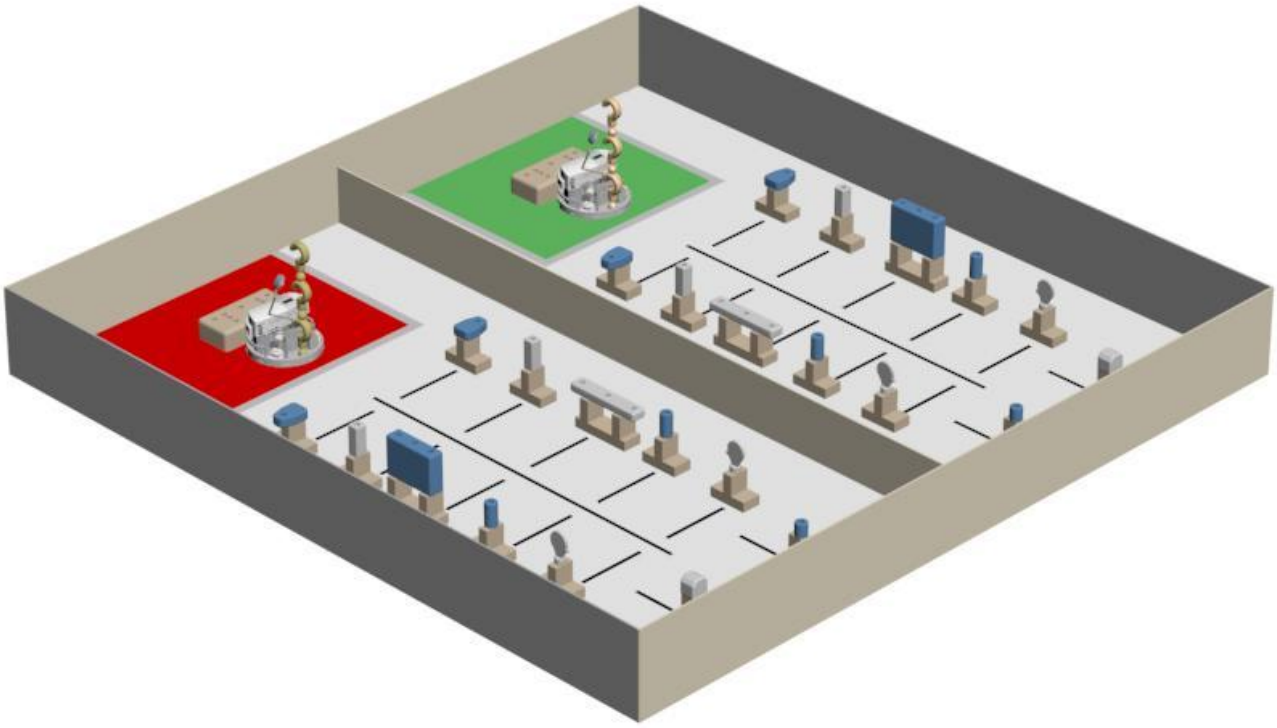
DRAFT
Test Project Proposal: Made in Germany

Final Text Version offered for consideration in the Approval Vote
WSC2013_TP23_AA_EN



Submitted by:
Name: Bob Tone, 2013 Mobile Robotics Expert
Member Country: Canada

INTRODUCTION

The **'Made in Germany'** task requires competitors to:

- Manage the mobility of an Autonomous Robot in a Simulated Manufacturing Facility
- Design / Fabricate / Utilize a Competitor Built Radio Controlled Object Management System to retrieve Robot Components from the Warehouse Area and Assemble Prescribed Robot Models in the Assembly Area

CONTENTS

This Test Project Proposal consists of the following documentation / files:

DESCRIPTION OF PROJECT AND TASKS

The Two Competitor Built / Radio Controlled Object Management System Courts each provide:

- Two Side by Side **Independent Simulated Manufacturing Facilities**
- The Robot Components in BOTH Independent Simulated Manufacturing Facilities are the same colour pattern
- 5 to 6 Teams of Competitors are expected to share the pair of Independent Simulated Manufacturing Facilities in each court during the 'Daily AM Shared Court Access Open Work Periods'
- All Teams of Competitors can expect to have 'Evaluation Task Runs' on BOTH of the Independent Simulated Manufacturing Facilities present in their Assigned Court
- There are NO Restrictions on how many Robot Components a Competition Robot may possess at one time. It is a Competitor Decision how often they will travel into the Warehouse (Pick One Robot Component each time they enter the Warehouse or enter the Warehouse less often and Pick Multiple Robot Components each time.)

The 'Simulated Manufacturing Facility' Court Elements

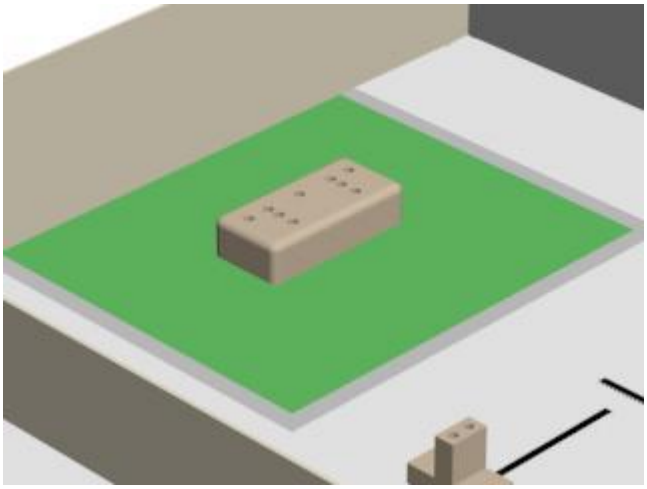
The Assembly Area

The Assembly Area is an 1100 by 950 mm space.

This area includes the Fixed In Position Assembly Base Block.

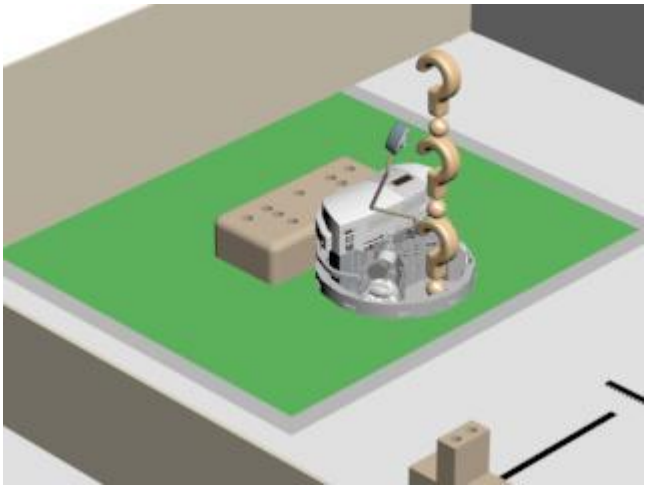
The top of the Assembly Base Block has multiple holes to enable it to support a variety of Designated Robot Solution Designs.

The Assembly Base Block has overall dimensions of: 420 by 200 by 100 mms.



The Robot Start Position

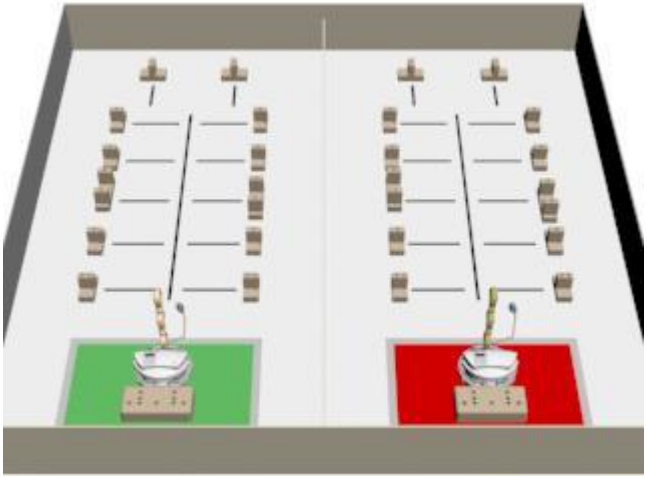
Robots start in the Assembly Area directly in front of the Assembly Base Block.



The Warehouse

Each Warehouse has 12 Robot Component Stands.

Each Warehouse Floor has a Pattern of Tape Lines available for use by Competitors when managing Robot Mobility.



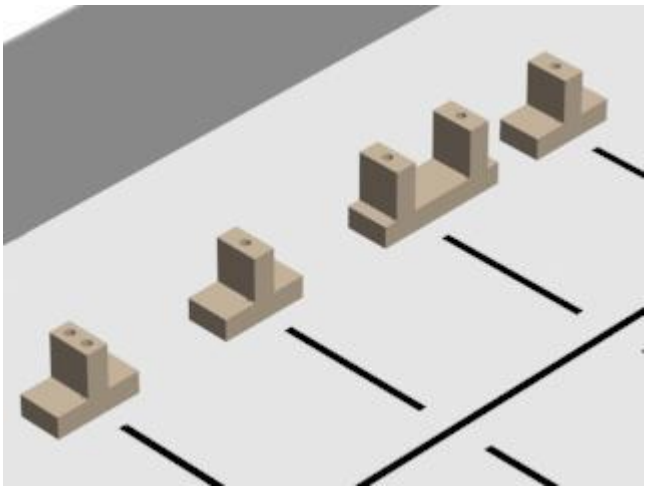
The Robot Component Stands

All Robot Component Stands are the same height.

Two Robot Component Stands have 2 Holes in their Top.

Eight Robot Component Stands have 1 Hole in their Top.

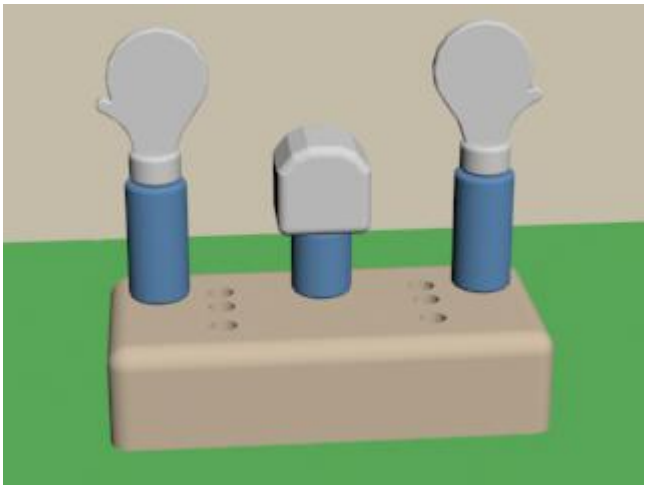
Two Robot Component Stands have 2 Vertical Ribs with 1 Hole in the Top of each Rib.



Prescribed Robot Solution Models

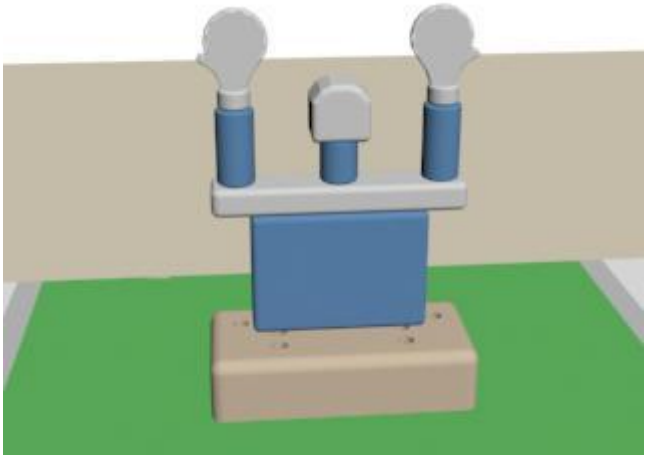
The 6 Component Robot Solution Model

- 1 Neck Component
- 2 Arm Components
- 2 Hand Components
- 1 Head Component



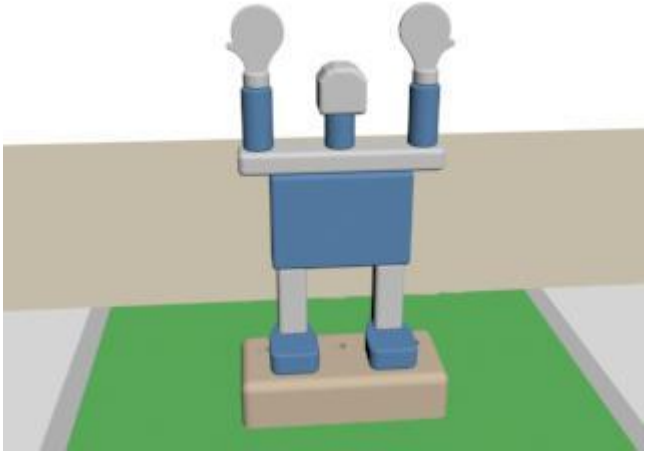
The 8 Component Robot Solution Model

- 1 Torso Component
- 1 Shoulder Component
- 1 Neck Component
- 2 Arm Components
- 2 Hand Components
- 1 Head Component



The 12 Component Robot Solution Model

- 2 Foot Components
- 2 Leg Components
- 1 Torso Component
- 1 Shoulder Component
- 1 Neck Component
- 2 Arm Components
- 2 Hand Components
- 1 Head Component



Marking

Marking will take place in two stages.

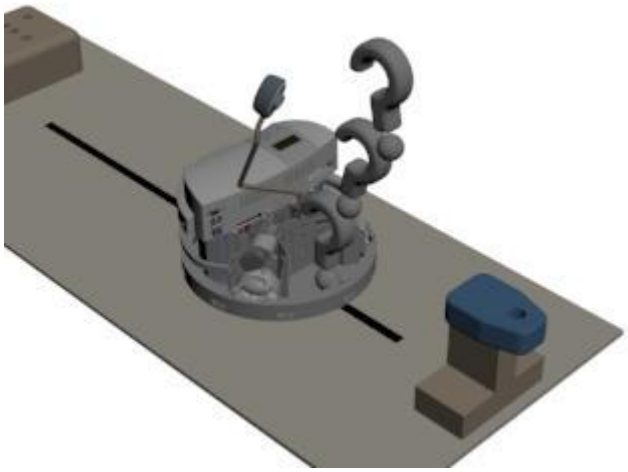
Stage One: **CBRCOMS Performance Specific Marking** involving CBRCOMS only and with the Tele-operator having Direct Line of Sight access to their CBRCOMS. Value 40% of the Overall Mark

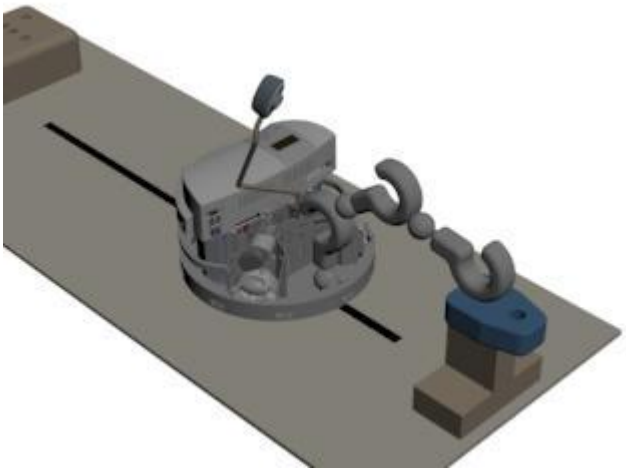
- Teams will have a Robot Performance Testing / Practice Space in their Assigned Workspace.
- It is expected that Teams will fabricate a minimum of One of each of the Three Robot Component Stands, and One Robot Assembly Base as well as One of each Robot Component for use during their Competition Preparation Activities and that they will bring these items to Leipzig for use in their Workspace.
- CBRCOMS Marking will take place during the AM Competition Sessions.
- CBRCOMS Marking will take place on the Robot Testing / Practice Space in each Team's own Assigned Workspace.
- CBRCOMS Marking will involve NO Robot Mobility Elements. Competitors will position their Robot in Front of the Component Stands and the Assembly Base prior to the Marking of each CBRCOMS Marking Element.
- CBRCOMS Marking will require each of the Eight Robot Components to be Lifted Clear of the Stand and held for 10 seconds.
- The Stationary Robotino positioned in front of the Assembly Base will be handed the Robot Components one at a time in the order they are required to build the Solution Robot Model.

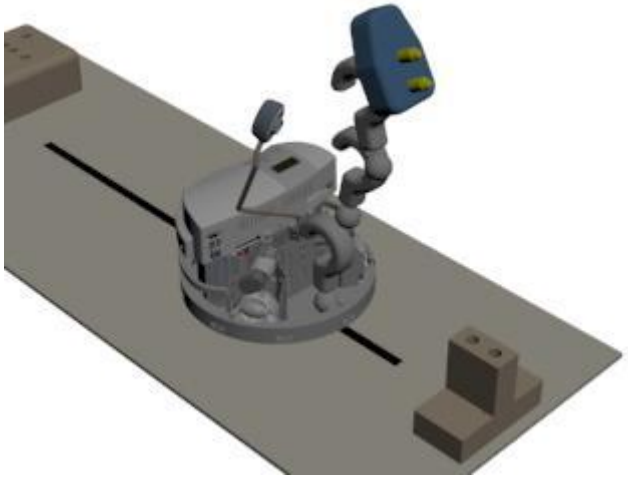
- CBRCOMS Marking will require the assembly of a Complete Robot Solution Model. Marks assigned per Robot Component will depend on the number of Components in the Robot Solution Model.
- Competitor provided Stands, Assembly Base and Robot Components will be examined and IF they are incompliance with the Competition Standard they will be used during the CBRCOMS Performance Specific Marking Process.

  Note: If the Competitor provided items are deemed to not be incompliance with the Competition Standard then an alternate set of Testing Elements will be provided and used for the CBRCOMS Performance Specific Marking Process.

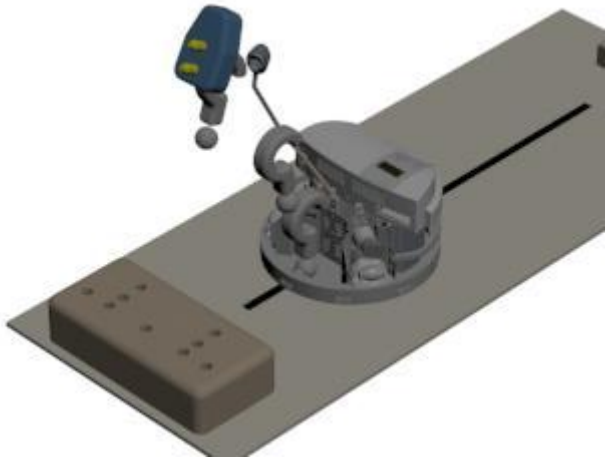
Workspace CBRCOMS Marking Sample

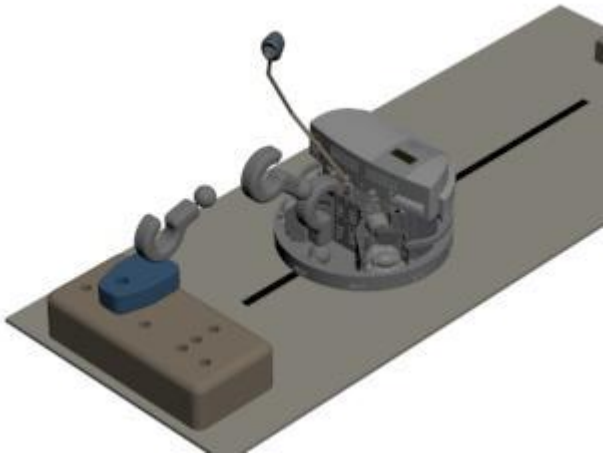


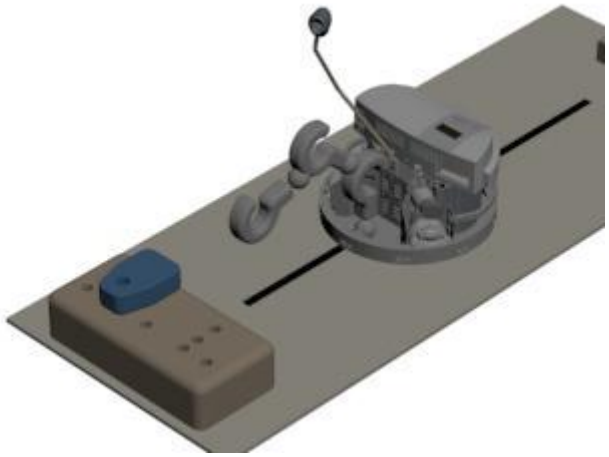




- Criterion One: Reach Out and contact the Robot Component on the Stand
- Criterion Two: Lift the Robot Component clear of the Stand
- Criterion Three: Hold the Robot Component for a Minimum of 10 Seconds







- Criterion One: Take Possession in your CBRCOMS of the Robot Component handed to it
- Criterion Two: Place the Robot Component in the Correct Location within the Assigned Robot Model
- Criterion Three: Move the CBRCOMS clear of the Assigned Robot Model

Stage Two: **On the Court in the Simulated Manufacturing Facility Complete Task Performance Marking** involving Robot Mobility and CBRCOMS Performance with all of the following options available and the Final Decisions being made in Leipzig. Value 60% of the Overall Mark

Marking

- All Marking will take place **AFTER an On the Court Evaluation Task Run Attempt has been COMPLETED**.

  Note: Two Teams will be making On the Court Task Run Attempts at the same time in side by side Independent Simulated Manufacturing Facilities.

  Note: The Two Teams will have a Single Shared Evaluation Task Run Start Time.

  Note: Competitors must remain OFF the court until Marking has been Completed for Both Teams.

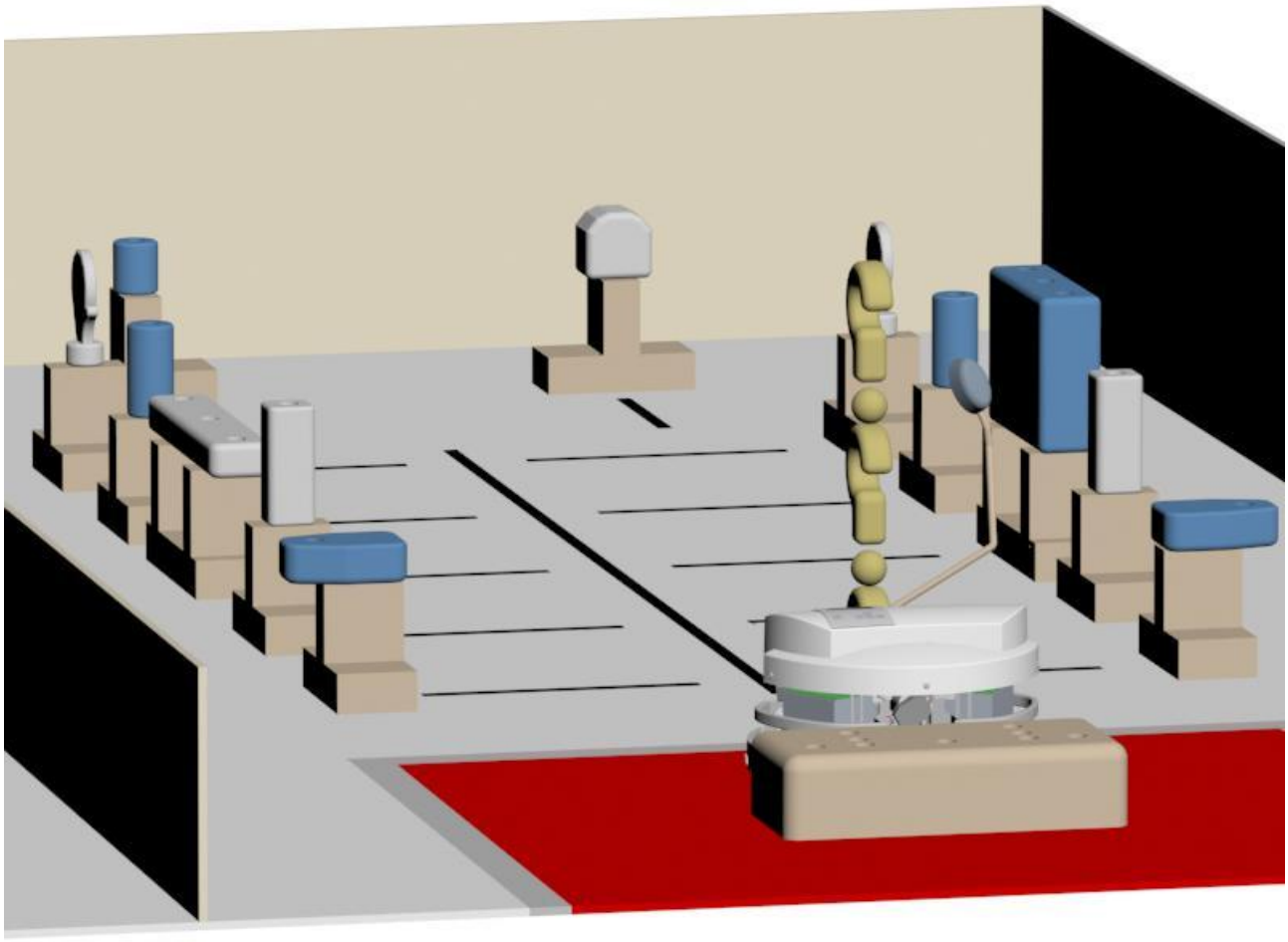
  Note: IF any time remains in the Assigned Evaluation Time Block after the Marking has been completed then Both Teams may use this time for On the Court Task Preparation.
- The Mark Value on a Per Component Basis will depend on the Number of Components in the Assigned Robot Solution Model and the Overall Number of Evaluation Task Runs available per Task.
- 70 % of each Evaluation Task Run's Marks will be awarded based on the Number of Robot Components delivered into the Assembly Area

- 20 % of each Evaluation Task Run's Marks will be awarded based on the Number of Robot Components correctly placed in the Assigned Robot Solution Model
- 10 % of each Evaluation Task Run's Marks will be awarded based on the Time Taken to build a Complete Assigned Robot Solution Model.

  Note: Time Marks will be calculated in the CIS based on the following formula: Overall Best Qualified Team Task Run Time / Individual Team's Qualified Time X Total Individual Task Run Time Marks available

  Note: The Number of Time Marks available per Task Run will depend on how many Evaluation Task Runs can be scheduled per Team.

Robot Component Placement in the Warehouse



Competitors MUST Understand that the Component Placement in the Warehouse Pattern displayed in this document is ONLY an Example of ONE Possible Component Placement in the Warehouse Pattern.

The Competition Leipzig Component Placement in the Warehouse Patterns will be determined during the Mobile Robotics Expert Jury Panel's Leipzig pre-competition meetings.

Competitors can expect that the Tape Line Pattern on the Warehouse Floor in Leipzig will be Exactly as shown.

The Robot Components will be the Same Colour Pattern in ALL Four of the Simulated Manufacturing Facilities.

Competitors will have both of their CBRCOMS Competition Day Task Experiences in the same court.

Competitors will have some Evaluation Task Runs in the Green Simulated Manufacturing Facility and some Evaluation Task Runs in the Red Simulated Manufacturing Facility.

The Robot Component Collection

Note: Individual Robot Components will be a Maximum Weight of 500 Grams.
Note: All Robot Component Surfaces will be Smooth, Painted and Non-porous.

The Robot Component Connection System

Uses Pegs placed in Holes to connect Robot Components.

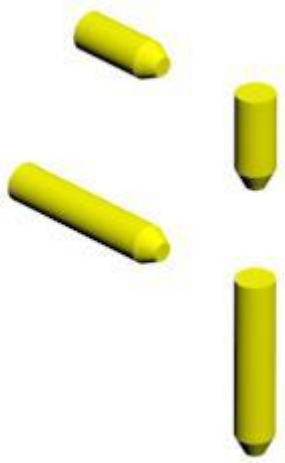
The Peg Diameter will be 2 mm less than the Hole Diameter.

One End of each Peg will have a 10 by 5 mm Chamfer.

The 2 mm Peg / Hole Diameter Difference will secure components in place.

The 5 mm Peg Chamfer will enable reliable positioning of Pegs in Holes.

The Neck Peg is longer than the other Pegs given it must pass through the Shoulder Component and into the Torso Component.

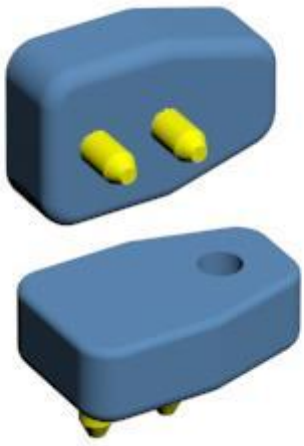


The Foot Component

The Foot Component has overall dimensions of: 150 by 100 by 50 mms.

The Foot Component has 2 Pegs for placement on the Component Stands and the Assembly Block.

The Foot Component has 1 Hole in the Top of the Foot to enable the Leg Component to be put in place.

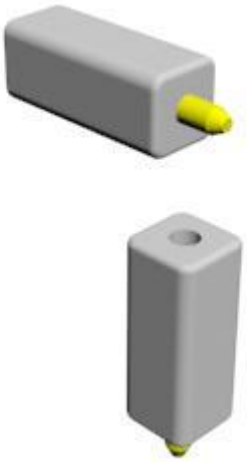


The Leg Component

The Leg Component has overall dimensions of: 150 by 60 by 60 mms.

The Leg Component has a Peg for placement on the Component Stands and the Foot Component.

The Leg Component has 1 Hole in the Top of the Leg to enable the Torso Component to be put in place.

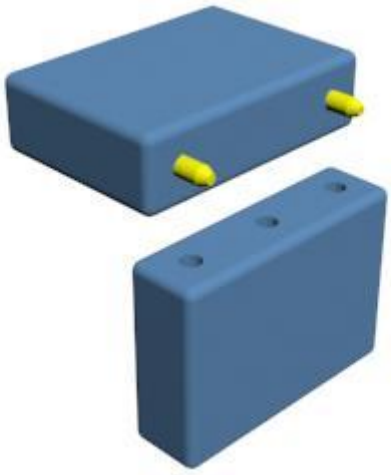


The Torso Component

The Torso Component has overall dimensions of: 280 by 200 by 40 mms.

The Torso Component has 2 Pegs for placement on the Component Stands and the Pair of Leg Components.

The Torso Component has 3 Holes in the Top of the Torso to enable the Shoulder and Neck Components to be put in place.

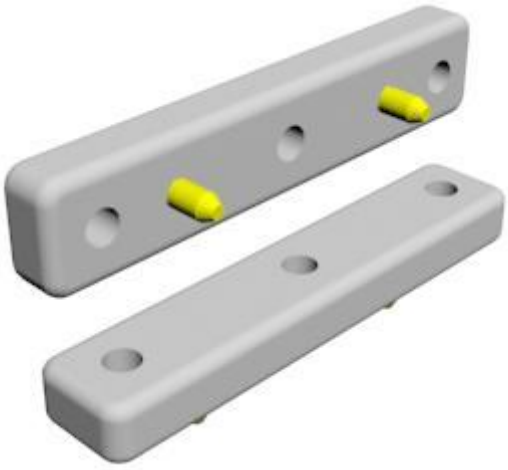


The Shoulder Component

The Shoulder Component has overall dimensions of: 400 by 80 by 15 mms.

The Shoulder Component has 2 Pegs for placement on the Component Stands and the Torso Component.

The Shoulder Component has 3 Holes Passing Through from the Top to the Bottom of the Shoulder to enable the 2 Arms and the Neck Components to be put in place.



The Neck Component

The Neck Component has overall dimensions of: 70 mm Long and a Dia. Of 60 mm.

The Neck Component has a Peg for placement on the Component Stands and the Shoulder Component.

The Neck Component Peg is longer to enable it to pass through the Shoulder and into the Torso to secure the Shoulder Component in place.

The Neck Component has 1 Hole in the Top of the Neck to enable the Head Component to be put in place.

The Head Component

The Head Component has overall dimensions of: 90 by 90 by 80 mms.

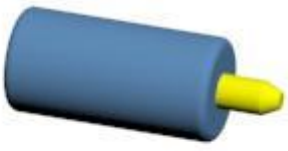
The Head Component has a Peg for placement on the Component Stands and the Neck Component.

The Arm Component

The Arm Component has overall dimensions of: 120 mm Long and a Dia. Of 60 mm.

The Arm Component has a Peg for placement on the Component Stands and the Shoulder Component.

The Arm Component has 1 Hole in the Top of the Arm to enable the Hand Component to be put in place.



The Hand Component

The Head Component has overall dimensions of: 126 by 107 by 15 mms.

The Head Component has a Peg for placement on the Component Stands and the Neck Component

INSTRUCTIONS TO THE COMPETITOR

Competitors are expected to demonstrate True Fair Play and Co-operation at all times but most particularly when they are sharing the court spaces during the AM Work Periods.

Given All of the Robot Components in the Side by Side Simulated Manufacturing Facilities are the Same Colour Pattern Competitors cannot use Camera Based Colour Analysis to locate Robot Components in the Warehouse.

EQUIPMENT, MACHINERY, INSTALLATIONS AND MATERIALS REQUIRED

Competitors are responsible to bring to the competition site and to use exclusively during the competition the Robot provided to them 6 months prior to the competition for use during their competition preparation activities.

Competitors are expected to bring ALL of their Competition Equipment in a container no larger than One Cubic Meter.

ON THE COURT MARKING SCHEME

Marking is based on **Three Criterion**:

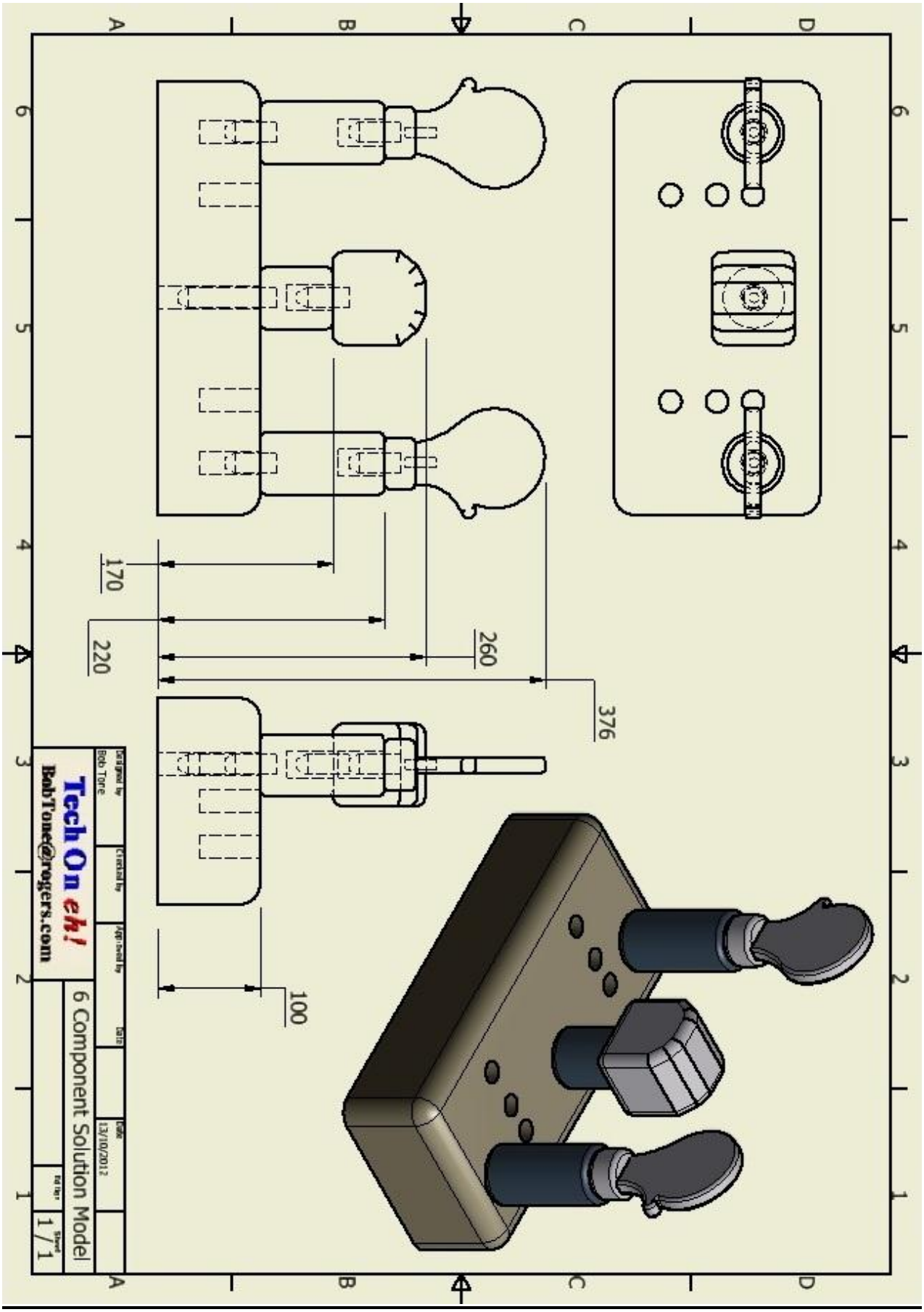
Criterion One: Delivery of Robot Components to the Designated Robot Assembly Area. Value 70% of the Marks available per Evaluation Task Run.

Criterion Two: Assembly of the Robot Components into a Robot. Value 20% of the Marks available per Evaluation Task Run.

Criterion Three: Time taken, Note: A Time Mark is only warded when a Complete Robot has been assembled. Value 10% of the Marks available per Evaluation Task Run.

COURT LAYOUT, ROBOT COMPONENT / FABRICATION, PRESCRIBED SOLUTION ROBOT MODEL DETAILS

- 6 Component Robot Solution Model Details
- 8 Component Robot Solution Model Details
- 12 Component Robot Solution Model Details
- Assembly Base Details
- Component Stand One Details
- Component Stand Two Details
- Component Stand Three Details
- Peg and Neck Details
- Foot Details
- Arm and Leg Details
- Hand Details
- Torso Details
- Shoulder Details
- Head Details
- Court Dimension Details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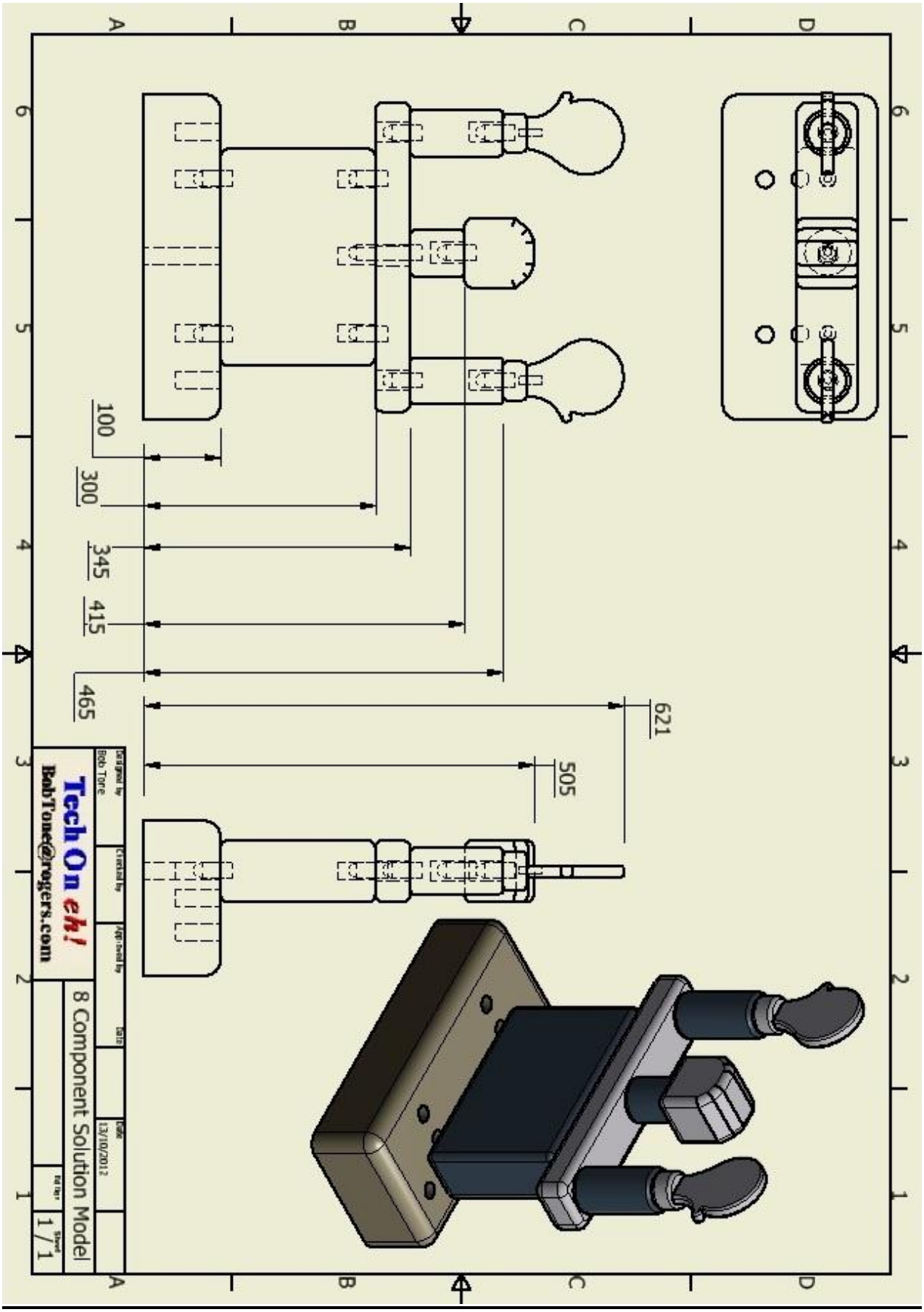
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8 Component Solution Model
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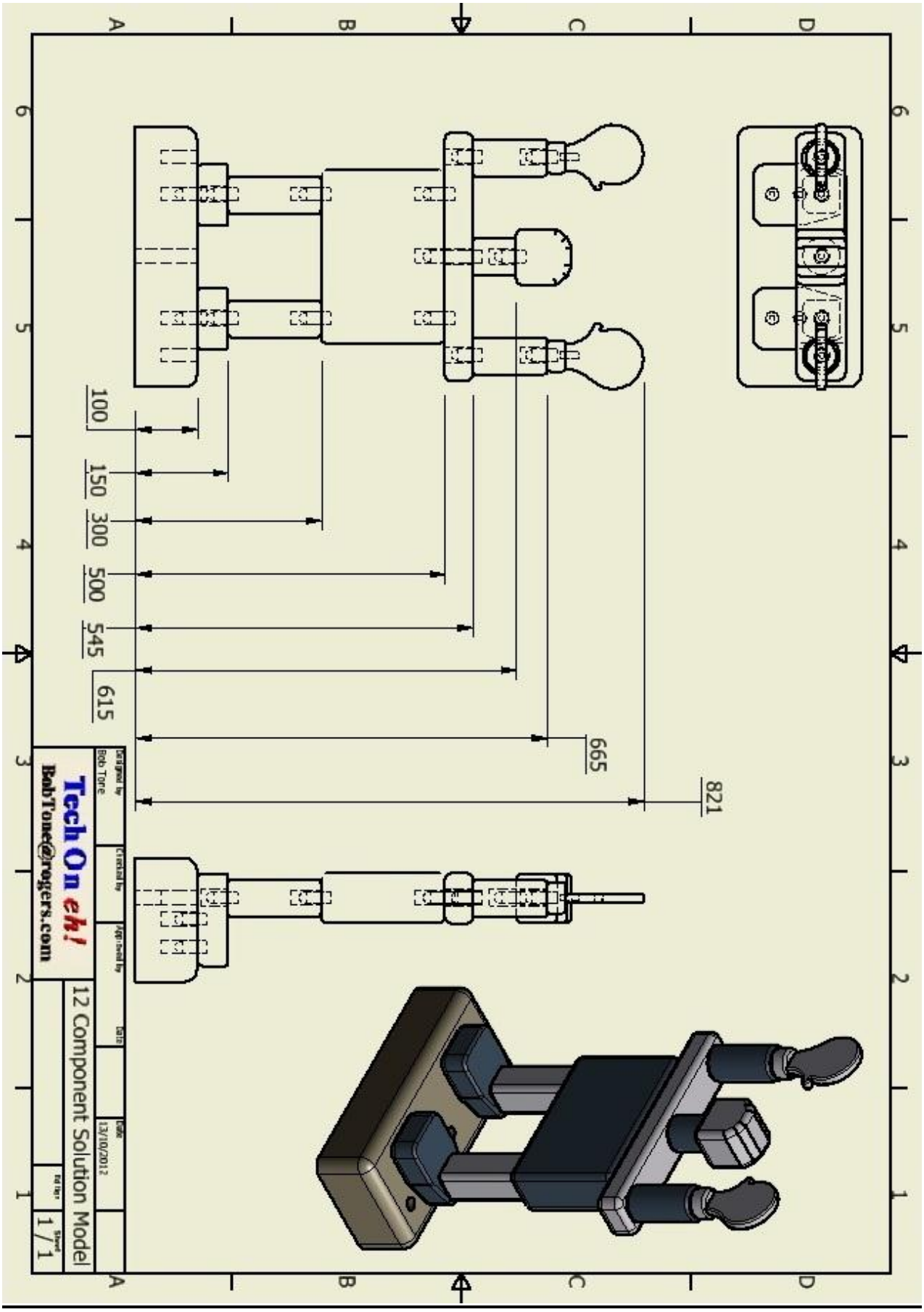
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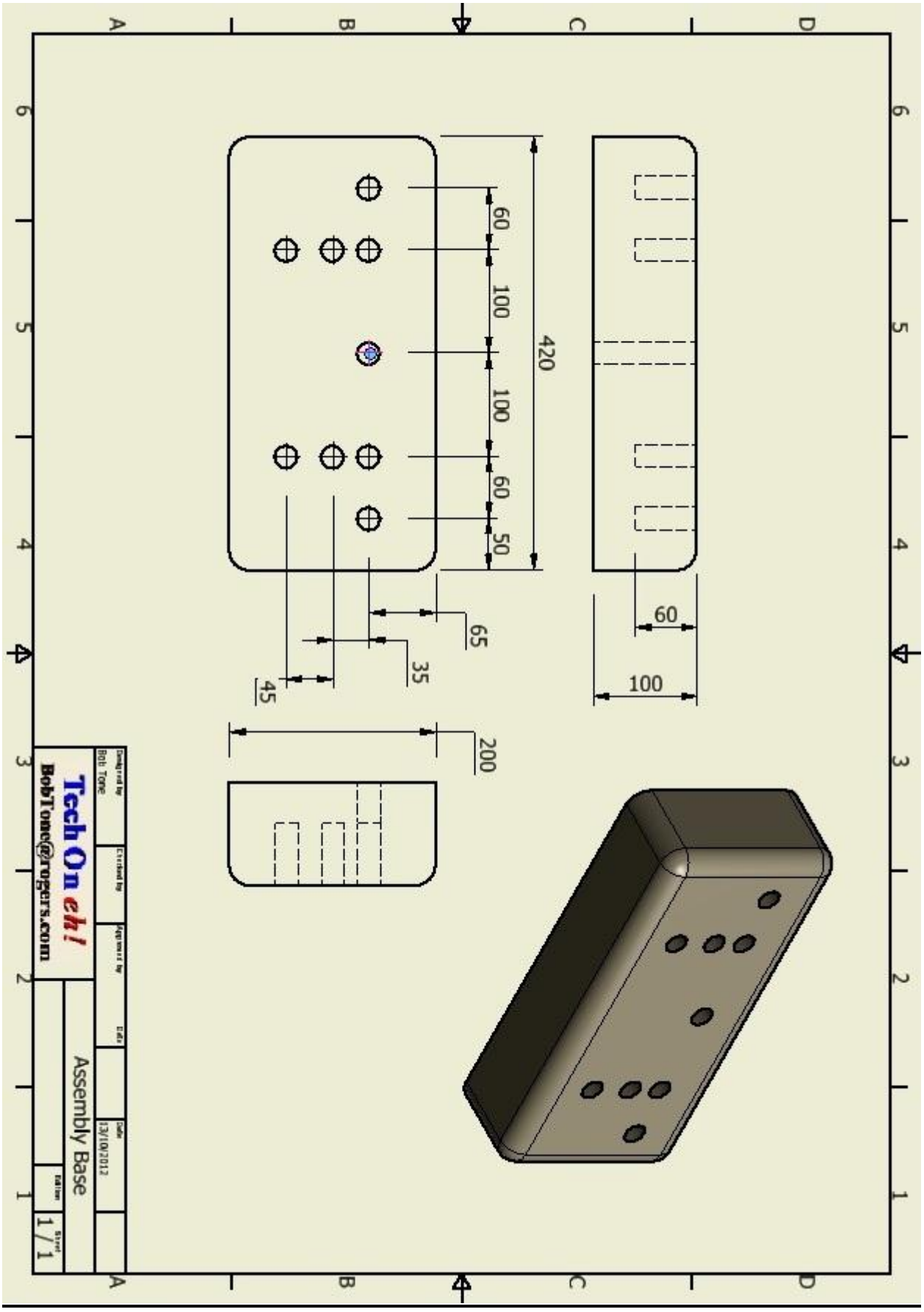
821
Tech On eh!
BobTonec@rogers.com
Bob Tonc
12 Component Solution Model
13/10/2012
1 / 1


60
100
100
60
50
420
65
35
45
200
60
100
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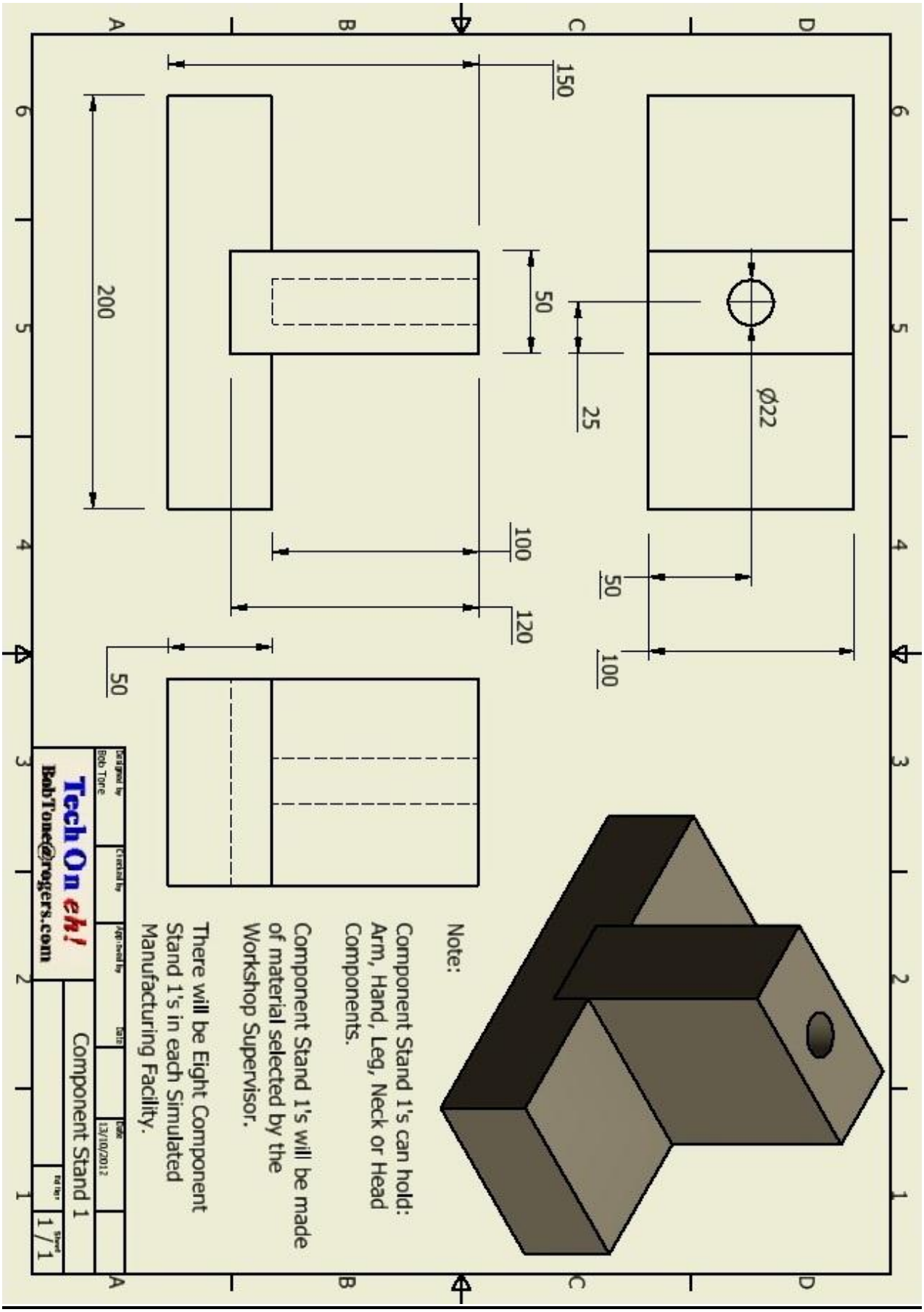
BobTone@rogers.com
Bob Tone
Assembly Base
13/10/2012
1 / 1


150
200
50
25
Ø22
50
100
100
120
50
Note:
Component Stand 1's can hold: Arm, Hand, Leg, Neck or Head Components.
Component Stand 1's will be made of material selected by the Workshop Supervisor.
There will be Eight Component Stand 1's in each Simulated Manufacturing Facility.
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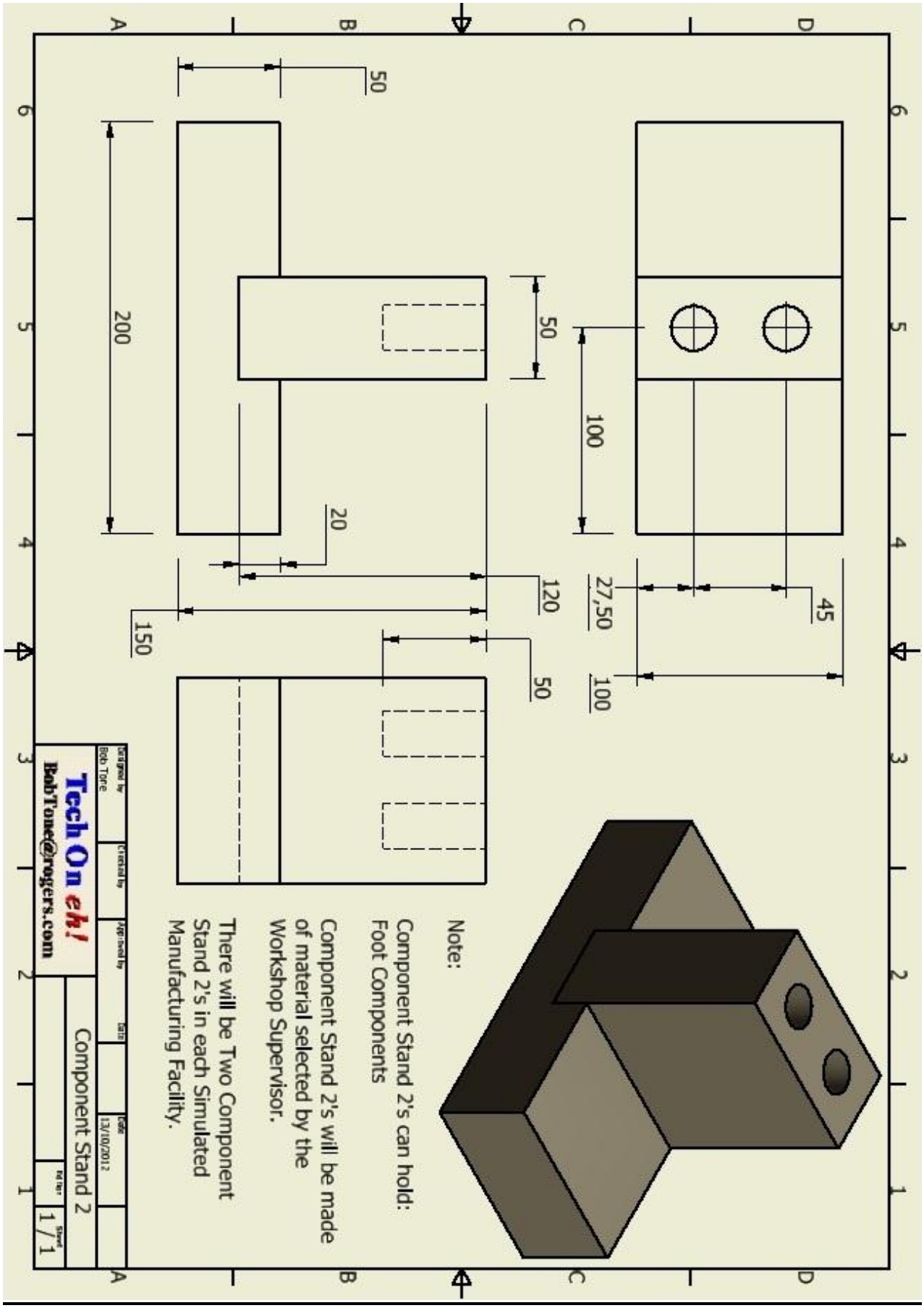
Component Stand 1
13/10/2012
1 / 1


50
200
50
100
20
120
150
50
27,50
45
100
Note:
Component Stand 2's can hold:
Foot Components
Component Stand 2's will be made
of material selected by the
Workshop Supervisor.
There will be Two Component
Stand 2's in each Simulated
Manufacturing Facility.
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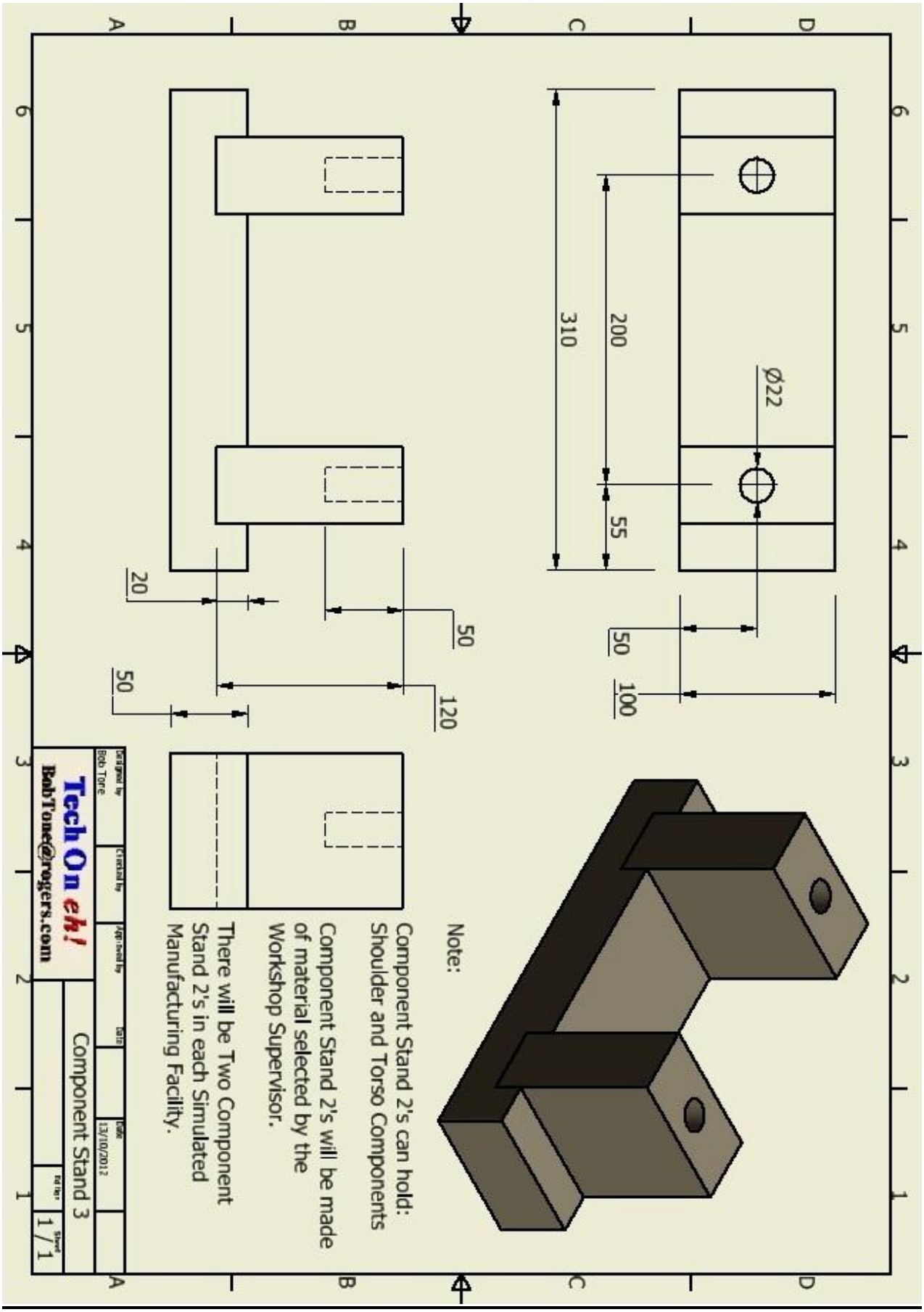
Component Stand 2
1 / 1
13/10/2012


Note:
Component Stand 2's can hold:
Shoulder and Torso Components
Component Stand 2's will be made
of material selected by the
Workshop Supervisor.
There will be Two Component
Stand 2's in each Simulated
Manufacturing Facility.
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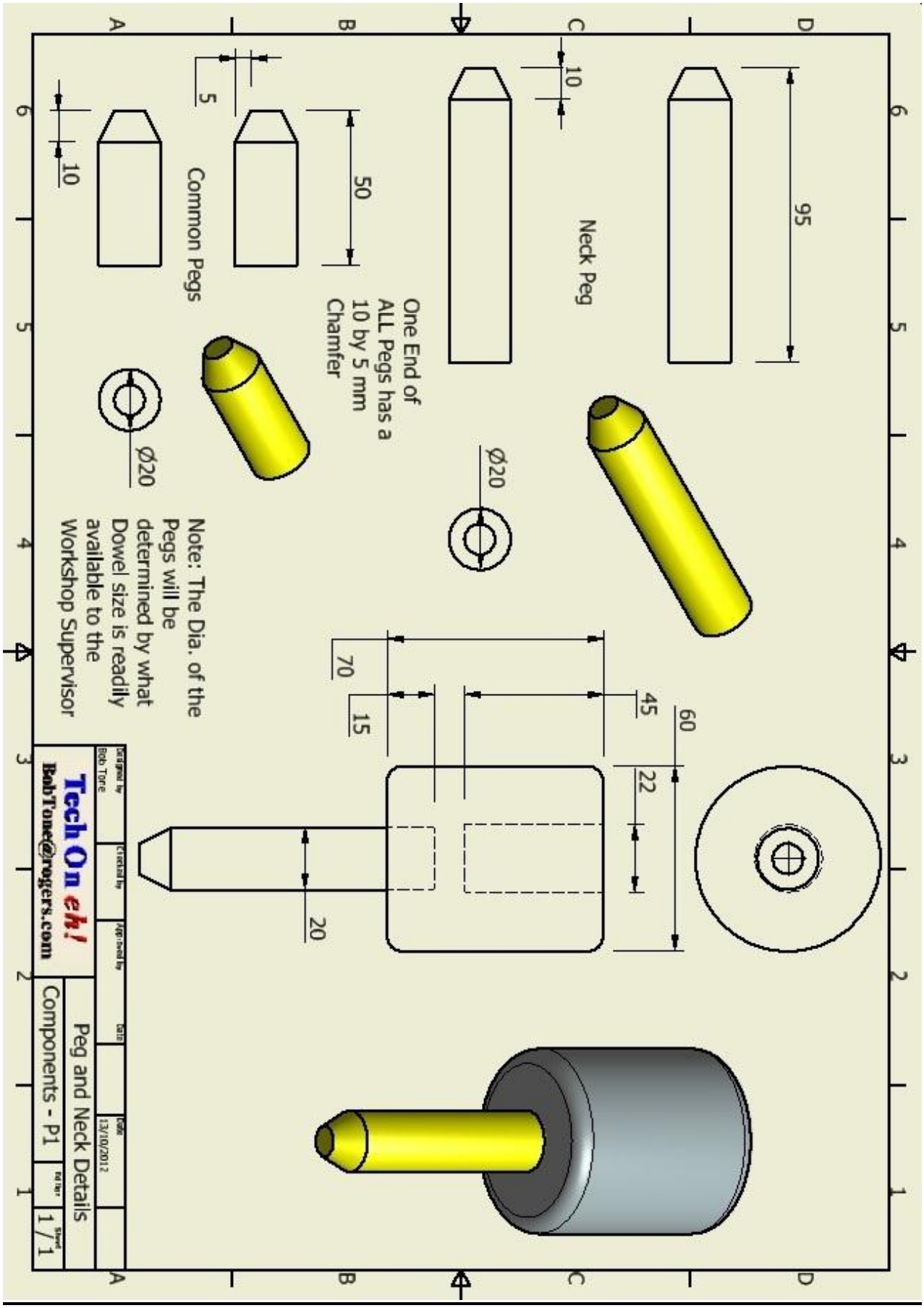
BobTonec@rogers.com
Component Stand 3
1 / 1
310
200
55
Ø22
50
100
20
50
50
120


Neck Peg
95
10
Common Pegs
5
50
10
One End of
ALL Pegs has a
10 by 5 mm
Chamfer
Ø20
Ø20
Note: The Dia. of the
Pegs will be
determined by what
Dowel size is readily
available to the
Workshop Supervisor
70
15
45
60
22
20
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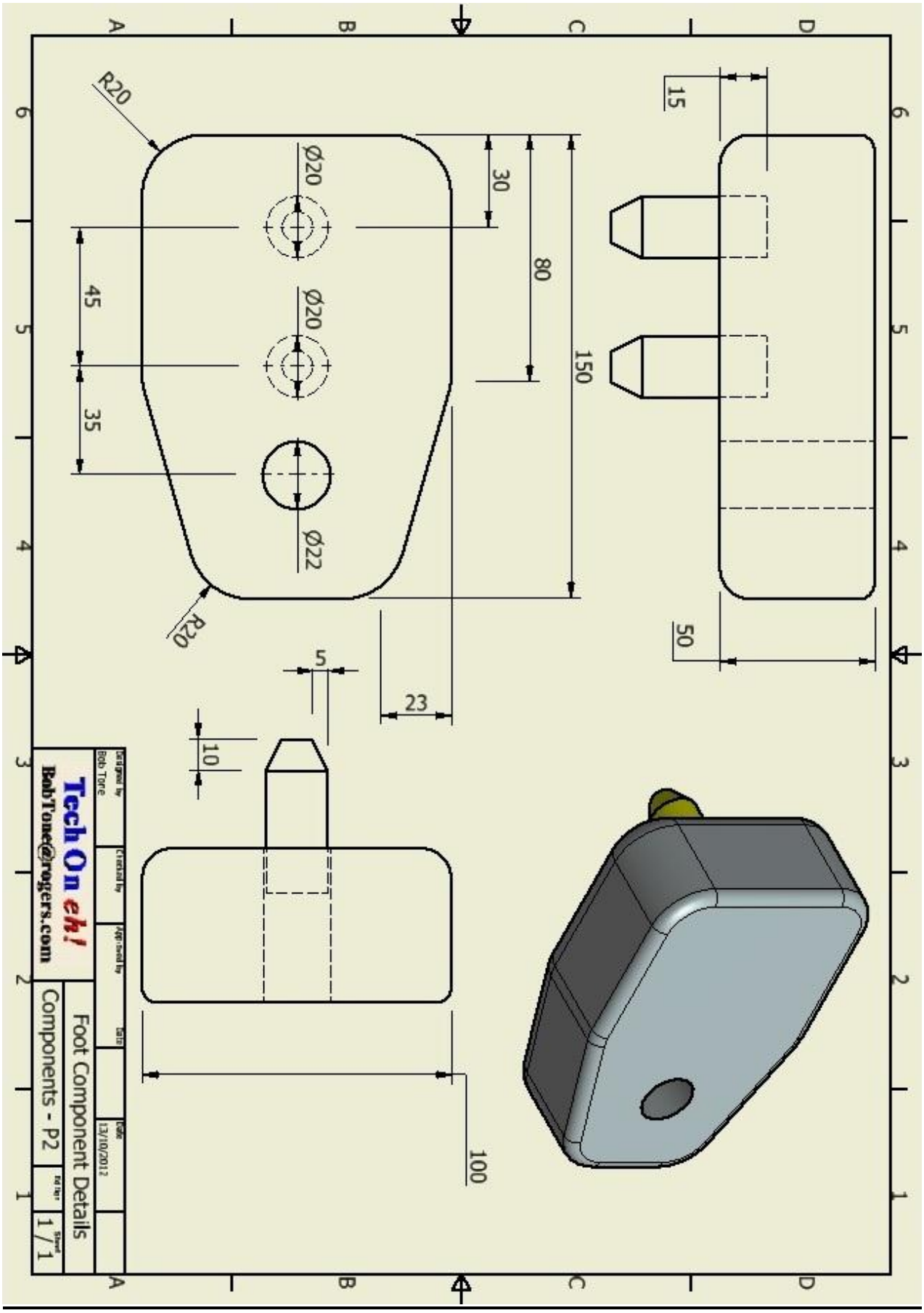
BobTunes@rogers.com
Peg and Neck Details
Components - P1
13/10/2012
1 / 1


R20
Ø20
Ø20
Ø22
R20
30
80
150
45
35
15
50
5
23
10
100
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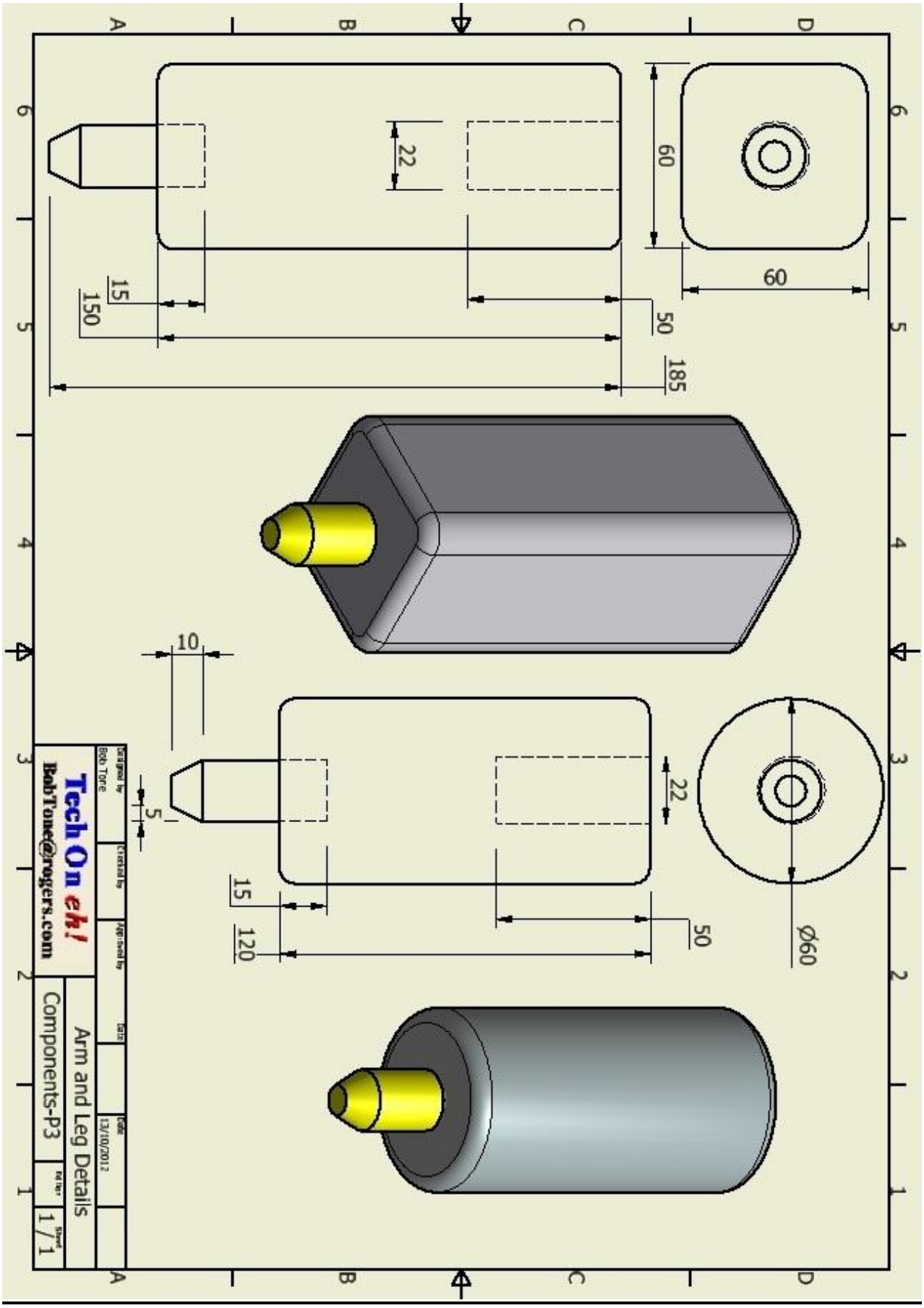
BobTonec@rogers.com
Foot Component Details
Components - P2
1 / 1
13/10/2012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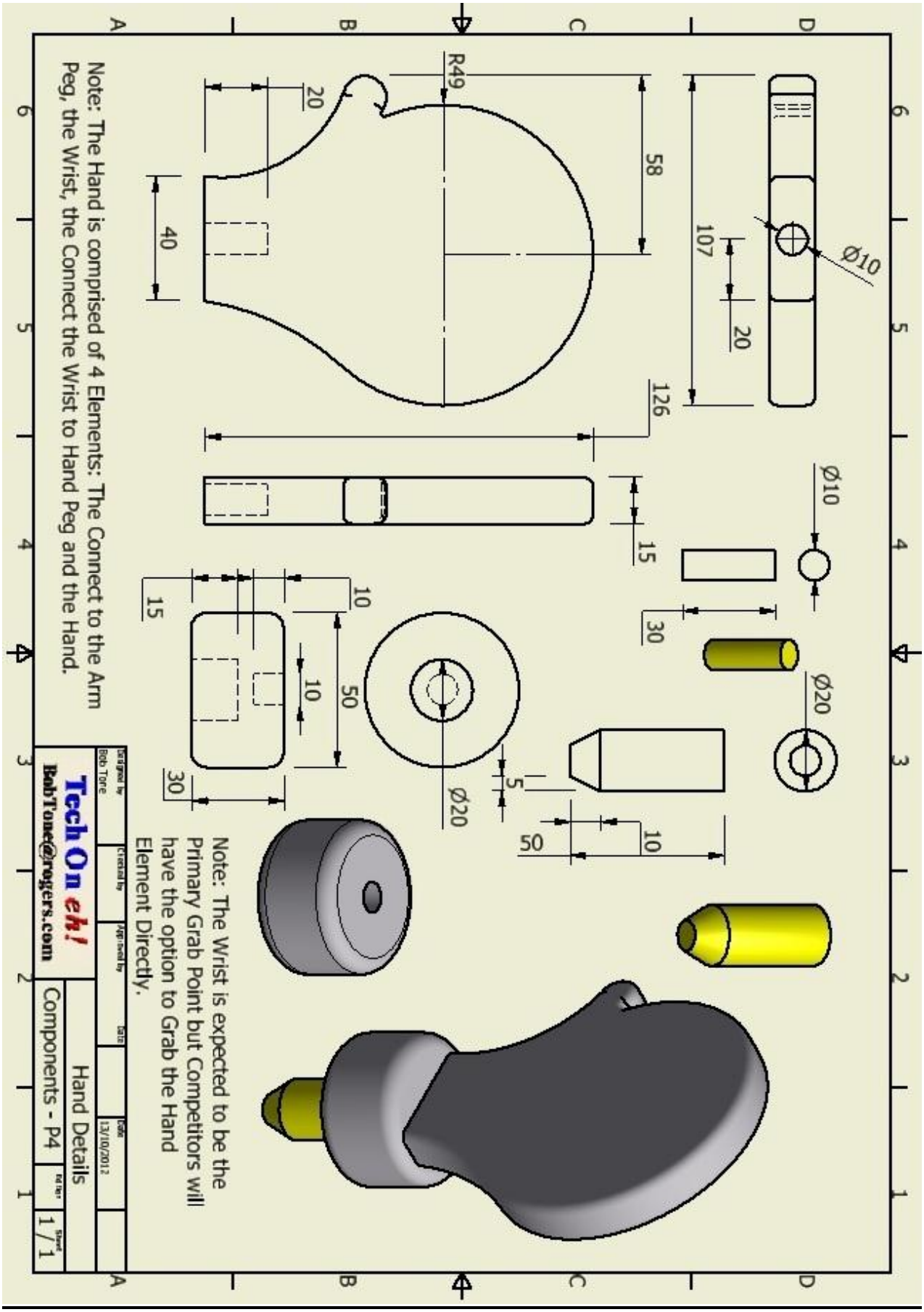
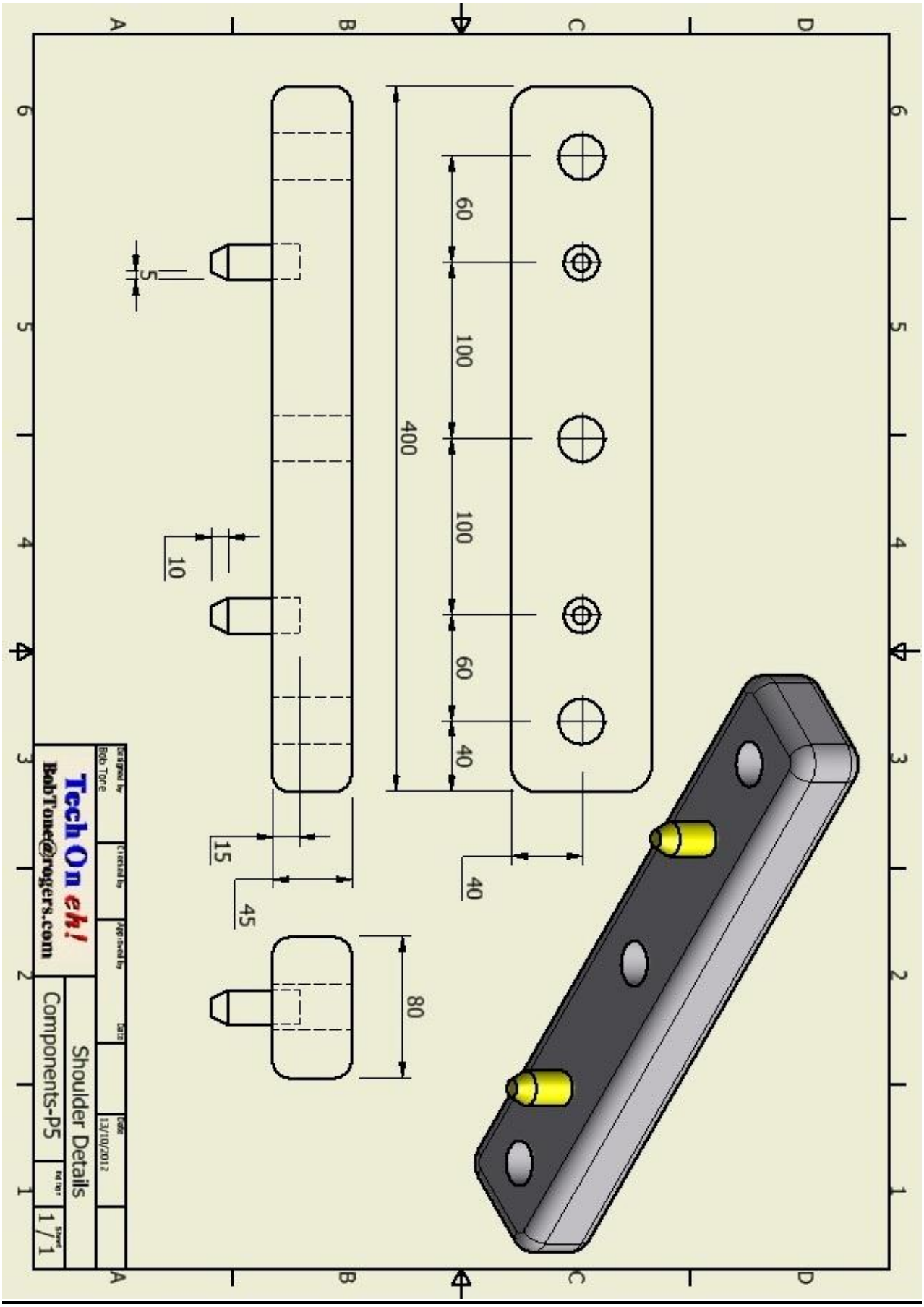
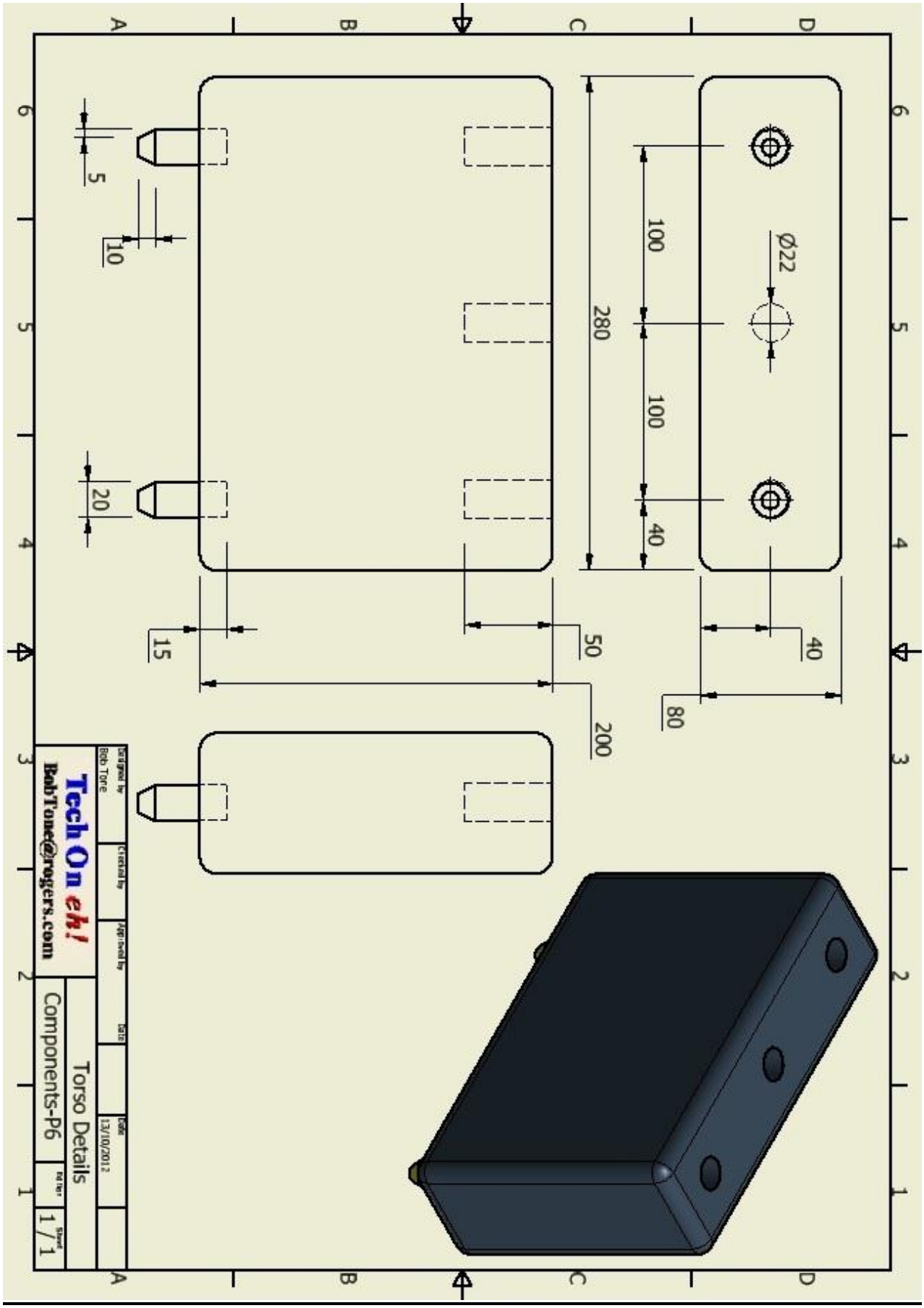
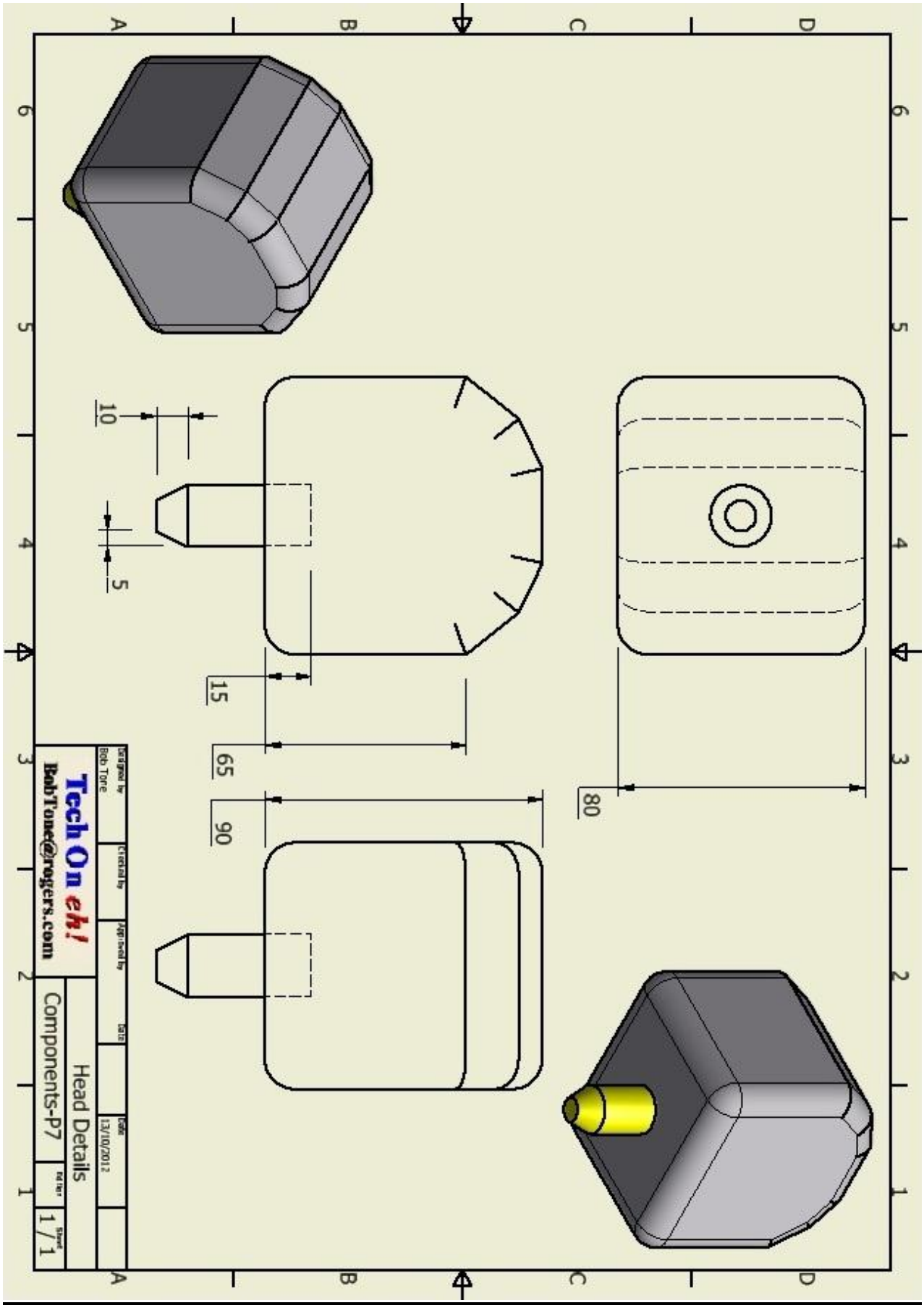
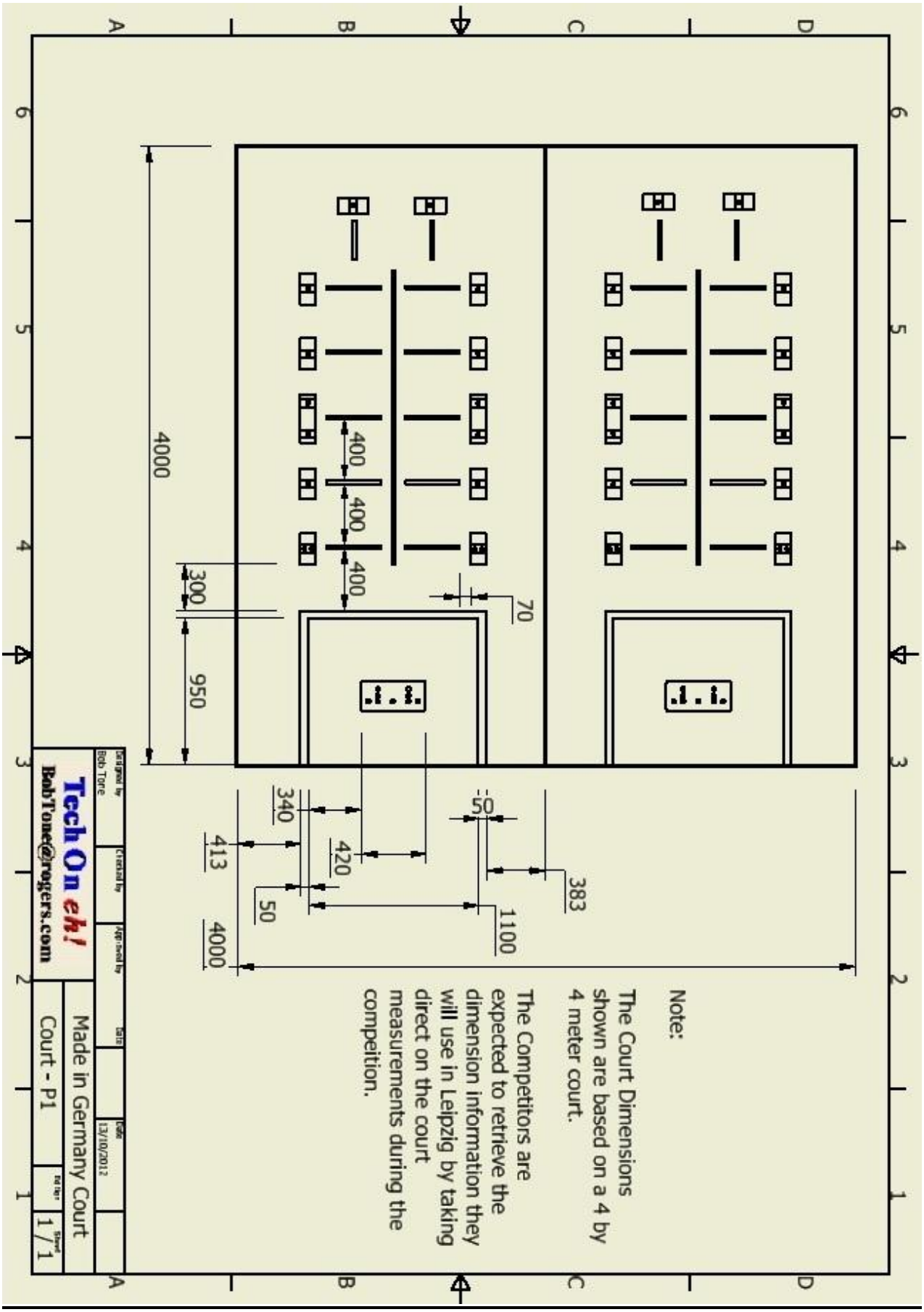
BobTone@rogers.com
Bob Tone
Arm and Leg Details
Components-P3
13/10/2012
1 / 1
22
60
60
15
150
50
185
10
5
22
15
120
50
Ø60


Note: The Hand is comprised of 4 Elements: The Connect to the Arm Peg, the Wrist, the Connect the Wrist to Hand Peg and the Hand.
Note: The Wrist is expected to be the Primary Grab Point but Competitors will have the option to Grab the Hand Element Directly.
Tech On eh!
BobTonec@rogers.com
Hand Details
Components - P4
1/1
13/10/2012


Designed by
Bob Tore
Checked by
Approved by
Date
Tech On eh!
BobTore@rogers.com
Shoulder Details
Components-P5
Edit
13/10/2012
Sheet
1 / 1
60
100
400
100
60
40
40
5
10
15
45
80


Ø22
100
100
40
280
40
80
50
200
15
20
10
5
Tech On eh!
BobTorre@rogers.com
Bob Torre
Torso Details
Components-P6
1 / 1


10
5
15
65
90
80
Tech On eh!
BobTone@rogers.com
Bob Tone
Head Details
Components-P7
13/10/2012
1 / 1


4000
400
400
400
300
950
70
340
413
420
50
-50
383
1100
4000
Note:
The Court Dimensions shown are based on a 4 by 4 meter court.
The Competitors are expected to retrieve the dimension information they will use in Leipzig by taking direct on the court measurements during the competion.
Tech On eh!
BobTone@rogers.com
Made in Germany Court
Court - P1
13/10/2012
1 / 1