



Work station for the medical diagnostic laboratory

A product design **project II** report

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Project guide

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Approval sheet

The project entitled " workstation for medical Diagnostic laboratories" by Ajay Desai is approved as partial fulfillment for the maters degree in industrial Design Center, Indian Institute of Technology, Bombay.

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Chairperson

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- Acknowledgement
- Approval sheet

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1. Introduction

1. Introduction

1.1 Diagnostic Market

- Indian diagnostic market, has undergone some major changes in the last four or five years with the advent of large pathology laboratories chain. Large path labs have been showing impressive growth rates of 50% over last year while the overall market growth was estimated at 25%, according to *metropolis studies claims, published in Lab Watch 16-30 June 2003.*
- Unlike US, in India a large portion of the market is still dominated by the unorganized sector, says experts which were mushroomed in the nineties to uncontrollable proportion, may be, since doctors too came under the consumer act 1989.
- In the consequences Pathology labs dependency over instrumentation is increased, which ensures accurate and fast results which is always been a need of the diagnostic market.

1.2 Instruments availability

- Most of the products available in the India for pathology laboratories are imported from countries like US, UK, France etc. which results tremendous cost increment due to conversion rates, excise duty and other taxes which makes instruments inaccessible to the most of the pathology laboratories in India. This is mostly either very small or belongs to unorganized sector, the labs of government hospitals, Small pathology labs, where cost sensitivity is very high among patients. This limits the laboratories to invest on instrumentation since they are costly, because they are imported.

1.3 Expert's availability and psychology

- Insufficient number of qualified doctors, in India, also one major reason to justify the importance of need to produce indigenously developed instruments on the other hand private labs no matters small or big, have tendency to possess higher degree of instrumentation, reasons are, firstly they like to have minimize their dependency over availability of experts. Generally they are available for short period.
- Secondly having high tech. look of the labs considered as more credibility among customers.
- The majority of the staff in labs is women so instrument should appeal them.

Introduction continued..

1.4 Divisions

- In pathology laboratory there are divisions like:
 - Biochemistry : to detect dissolved chemicals in blood.
 - Microbiology: Detecting, identifying and finding drug sensitivity of microorganism
 - Hematology: Analysis of blood cell components
 - Histopathology: Tissue analysis
 - Immunology : Analysis of Allergies and abnormalities
- Level of automation and instrumentation differs from divisions to divisions, it is been observed that in the area of microbiology it is quite low, particularly in solid phase antibiotic sensitivity tests.
- In India practice of this test is increasing, need is been felt to predetermine the intensity of the drug to be given according the bacterial infection.
- Antibiotic sensitivity also practiced by food and pharmaceutical industries which itself is a vast area of similar product requirements.

1.5 Scope

- In India as per conventional thinking, availability of inexpensive workforce is still a better choice over expensive automation or instrumentation among many labs, still measures for:
 - Occupational hazards
 - Environmental Safety
 - Accuracy of the results
 - Convenience
 - Time
 - Affordability of Imported instrument
 - Minimizing the likely errors, are the issues where importance of instrumentation is not questionable.

2. Aim of the project

Designing a product (workstation) for medical diagnostic laboratories, particularly for the microbiology division, to facilitate the performance of

- routine,
- repetitive,
- hazardous,
- microbiology tests and other laboratory activities,

which will ensure

- disciplined working, and
- optimum safety ,

to the

- users,
- Samples/ product,
- And Environment

Also provide feel good factor to the user and satisfies the general psychology of the potential buyers.

3. Scope of the project

- Since the idea of the project is based on a problem discussed by a doctor, owning a pathology laboratory, later we came up with a hypothetical product concept, and lot many questions arises like:
 - Is this product is available?
 - Are there are any products which are similar to our hypothetical product concept?
 - There are few products found e.g. anaerobic workstation
 - Are there are any products which may be part of the hypothetical product concept?
 - Yes, e.g. Turn table, laminar flow, bio safety cabinets, loop sterilizer, petri dish and antibiotic disk dispenser, holding equipments for various instruments.

- What is the scope of the project ? or will it be needed by enough medical diagnostic labs?
 - Task was to get enough supportive data that is from at least 10 doctors plus actual users to confirm the scope.

- After establishing the scope of the project, further queries were to be solved, e.g:
 - How does process works?
 - What is the micro steps involved in the whole process?
 - What user wants?
 - What user does not want?
 - and so on
 - To get the answer of these question second extensive user study had been started.

4. Data collection and user survey

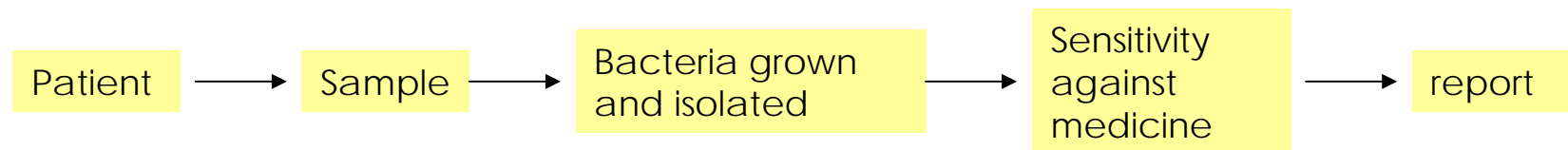
4.1 The Domain

Few Characteristics of the microbiology laboratories in Hospitals and pathology laboratories:

- scenario
 - Every lab , necessarily does not have microbiology facility and expertise, they send samples other labs.
 - Developing Fast as business.
 - Awareness among patients is increasing.
 - High utility activity in Health care, Food, Pharmaceuticals & other Industries.
 - Least automation.
 - Somewhat neglected area so far.
 - Time is crucial e.g. need to reduce time in tuberculosis test.
- Process
 - Lack of discipline for following standard safety norms as compare to Europe and US.
 - Tediousness of the media preparation.
 - Lengthy process of sensitivity testing.
- Size
 - Investment varies from 50,000 to 10 crores, in most cases 4-5 lacs of investment.
 - Generally 500 sq. ft. area is comfortable.
- people
 - Run by MD, PG diploma doctors, some even after MBBS.
 - Most of the labs are conventional in there method of working.
 - Doctors doing clinical practice, started using more frequently and relying more on test results.
 - Routine work generally done by lab technicians

4.2 Testing process

- In general the test procedure is as follows:



- Antibiotic sensitivity tests:
 - Reliable way of confirming extent and cause of the illness and intensity of drugs to be given.
 - A test to determine the effectiveness of antibiotic therapy against microorganisms that have been isolated and identified from cultures.

4.3 Ant microbial sensitivity testing

ANTIMICROBIAL SENSITIVITY TESTING (Solid Phase)

ork station for medical diagnostic lab

- Thin spread
- Protection from environmental contamination
- Worker's safety

Sample collection

- Different container for different type of samples

Registration

Sample Preparation

- Organism should be alive in the process

Inoculation

Isolation

- Standard soln. Of barium chloride for comparison

Incubation

Plating

- Uniform distribution
- Holding the petri dish during plating
- Holding test tube, sterilizing loop, swabs
- contamination from environment and worker

Reading

- Reading Diameter of inhibition area of the colony grown around Antibiotic disk

Antibiotic Selection

- Selection of antibiotic disk to put
- Cartridge or by fork

Placing

- Dispensing from cartridge
- Placing manually one by one by fork

Comparison

- Reading of inhibition area and comparing it with standard value

Conclusion

Report

Incineration

Sterilization

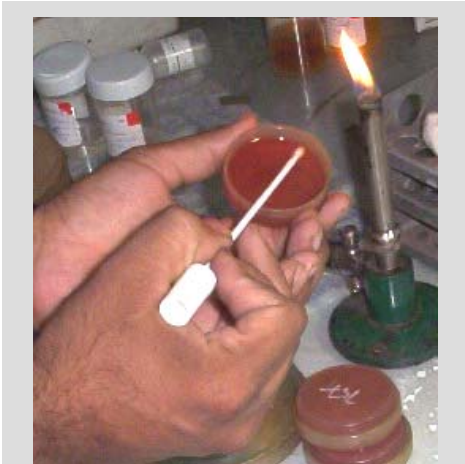
4.3.1 Images of the process



Patient Registration and Sample collection



preparation Media pouring



Streaking of sample on petri dish



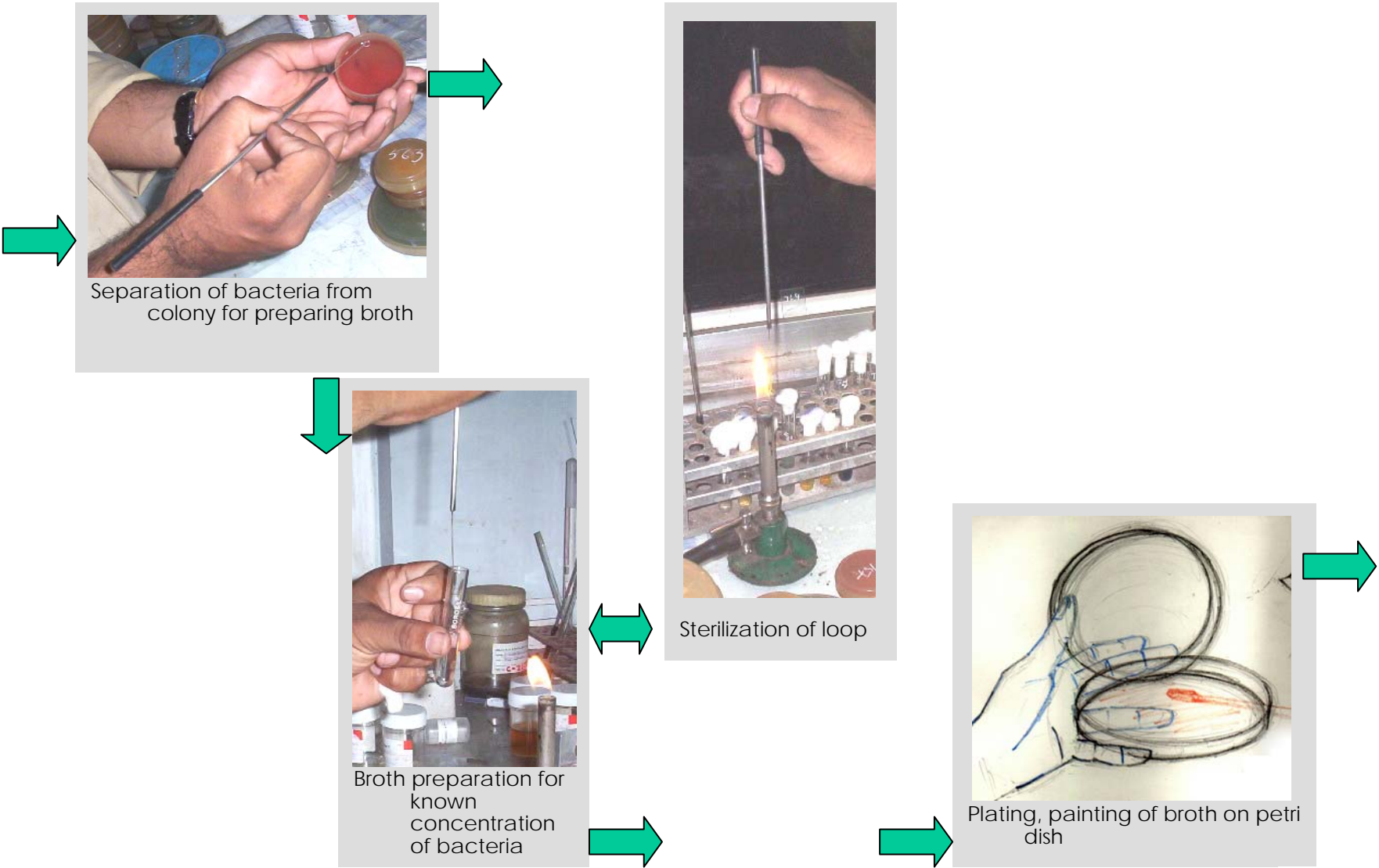
Incubation in air at 35-37deg.C. For 16-18 hrs.



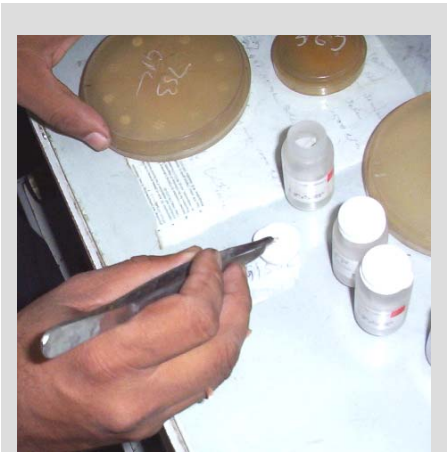
Growth of the colonies by bacteria



4.3.1 Images of the process



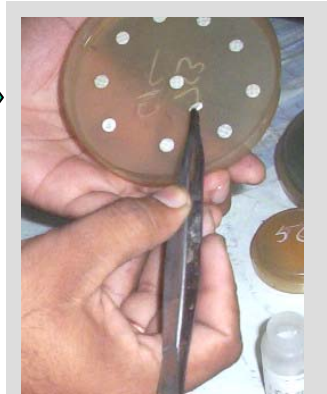
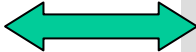
4.3.1 Images of the process



Selection of Antibiotic disk
Picking disk by fork



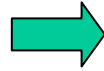
Sterilization of fork



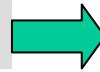
placing of
Antibiotic disk

1

4.3.1 Images of the process



Incubation in air at 35-37deg.C.
For 16-18 hrs.



Bacteria develop their colony. If sensitive for particular antibiotic leaves Inhibition area around disk.



Observations,
Size of the inhibition
area decides
the level of
sensitivity

4.4 Equipments, Instruments and accessories in use

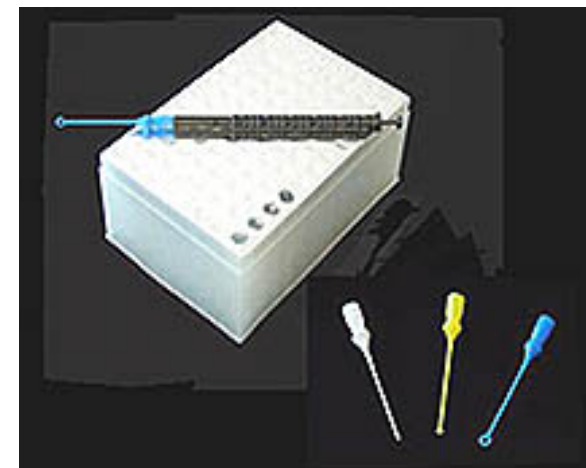
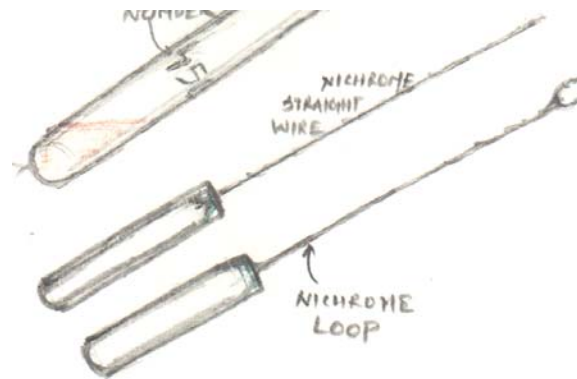
■ Cotton swab

- For streaking and plating of sample and broth solution on petri dish.



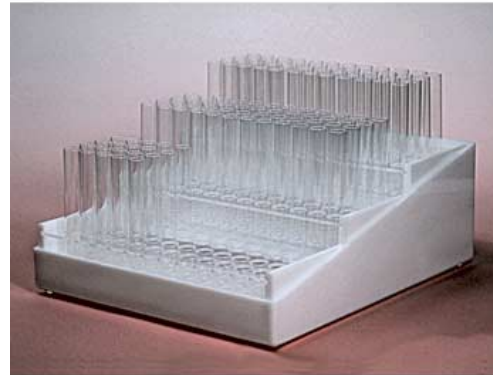
■ Loop/Wire

- Special metal wire, in straight and loop form for separation /isolation of bacteria from their colonies.



4.4 Equipments, Instruments and accessories in use

- Test tubes
For broth solution etc.
- Test tube holders



- Slides
- Slide holder



4.4 Equipments, Instruments and accessories continued..

■ Petri dishes

- Transparent
- For colony culture



■ Petri dishes organizer



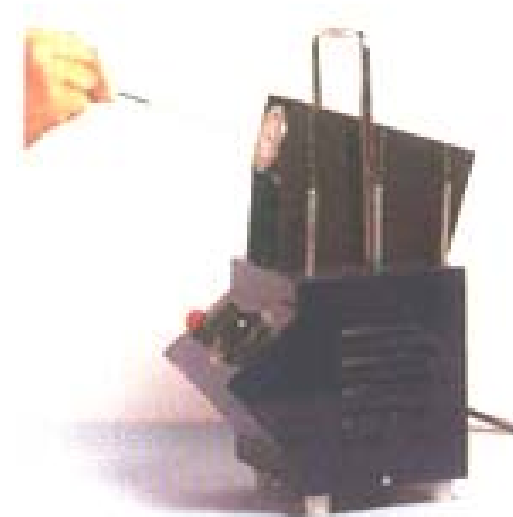
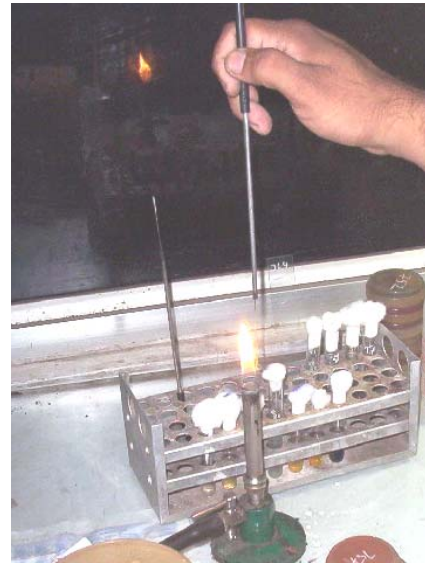
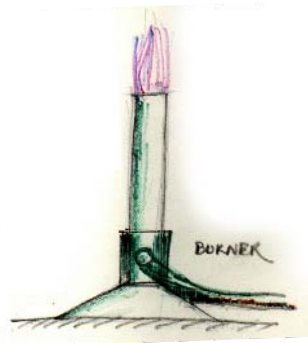
4.4 Equipments, Instruments and accessories continued..



- Turntable
- For plating and streaking

4.4 Equipments, Instruments and accessories continued..

■ Burners/ sterilizer



■ Density/ turbidity meter

- To know the concentration of bacteria in broth solution



4.4 Equipments, Instruments and accessories continued..

- Pipettes
 - For taking & delivering precise quantity on liquids



- Incubator

4.4 Equipments, Instruments and accessories continued

- Antibiotic Disk dispenser
 - Dispense the antibiotic disk on plated petri dish for sensitivity test



- Autoclave
 - sterilize the things by steam



4.4.1 Bio safety cabinets



■ Bio safety cabinets

4.4.1 Bio safety cabinet classification

■ The Class I

- A ventilated cabinet with an inward airflow and outlet HEPA filters. It was previously referred to as the CDC Hood and served a valuable function in its time by protecting personnel and the environment. Because it offers no product protection, it has been essentially obsolete for the past several decades.

■ The Class II

- Is Laminar Flow Biological Safety Cabinets that protect personnel, product and environment. They provide inward airflow to protect personnel, down flow HEPA filtered air to the work area to protect the product and exhaust HEPA filtered air to protect the environment from particulate and aerosol hazards.

■ The Class III

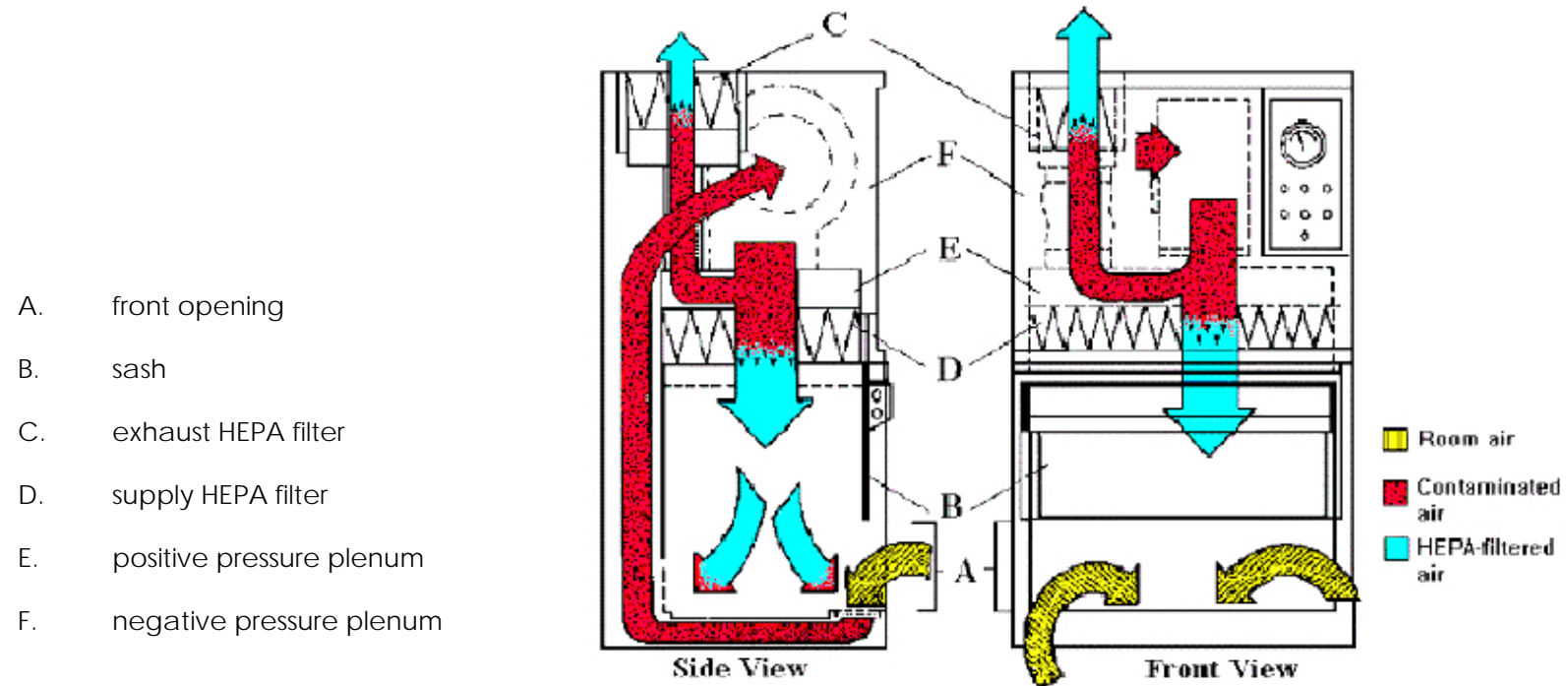
- cabinet is defined as ventilated Glove box. This is a gas-tight chamber operated through sealed gloves which provides a complete barrier between the worker and hazardous material. The Glove box is maintained under negative pressure with HEPA filtered supply air and double HEPA filtered exhaust air.

4.4.2 Selection of a Safety Cabinet Through Risk Assessment

Biological Risk Assessed	Protection Provided			BSC Class
	Personnel	Product	Environmental	
* 1-3	YES	NO	YES	I
1-3	YES	YES	YES	II
4	YES	YES	YES	III

* In the scale of Risk level 1-4

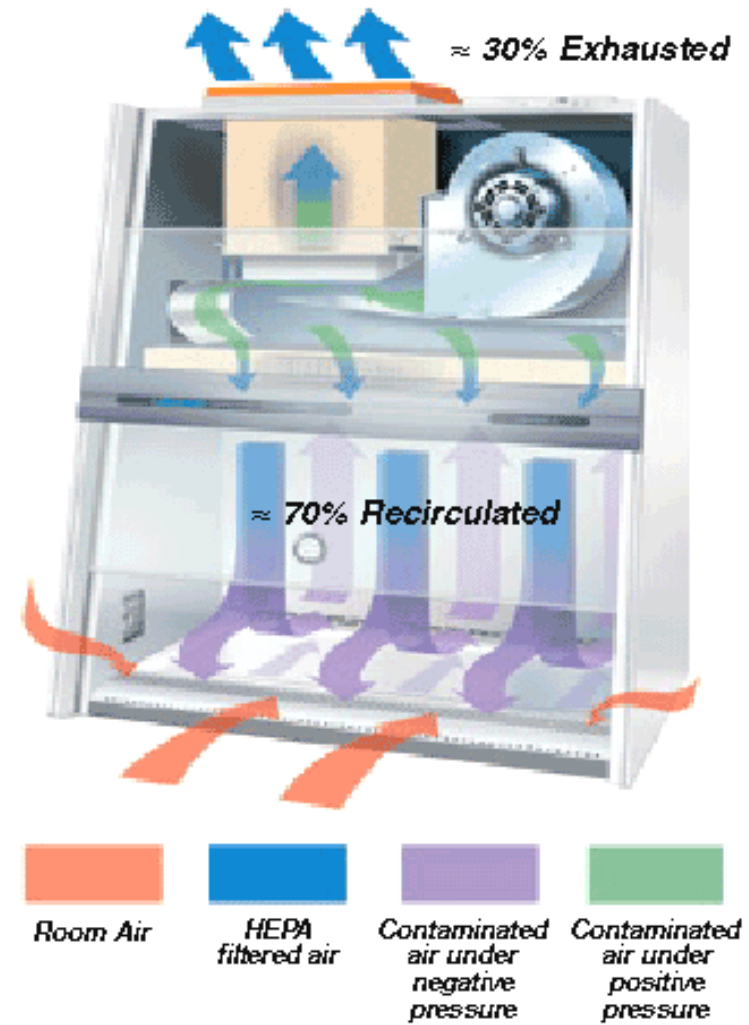
4.4.3 The tabletop model of a Class II, BSC.



■ The cabinet exhaust needs to be connected to the building exhaust system.

■ Source: <http://www.orcbs.msu.edu/biological/bsc/fig5a.htm>

4.4.3 The tabletop model of a Class II, Type B3 BSC. Continued..



Source : <http://terrauniversal.com/products/hoods/index.html>

4.4.4 Dimensions and Costing

- Vertical Laminar Flow cabinets

Dimensions are in Inches
Source : Kasliwal scientific equipments, Indore

Size	Cost
24x24x24	40000
36x24x24	45000
72x24x24	75000
48x24x24	55000

- Bench top dimensions of forensic category

Source : <http://www.terraforensic.com/index.shtml>

2MP	28X16X16
2MP	33X12X18
3.5MP	40X28X20
4MP	148X30X30

4.5 User survey

4.5.1 User Survey chart

		Registration	Plate Preparation	Plating	Disk Dispensing	Laminar Flow / Hood	Colony Reading	Turbidity meter	incubator	Holders for tubes, Dishes
Dr.Tripathi	BPL			y	Y	y		y		y
Dr.Natrajan	KEM			y	y					y
Dr.Baweja	KEM							y		y
Dr.Mehta	KEM							y		
Dr. Nagendra	AFMC		Y	y	y	y	y			
Dr.Chunber	AFMC		Y	y	y	y	y			
Dr.Sawhney	AFMC					y	y			
Dr.Jain	LONI		y	y	y		y	y		
Dr.Biswas	TATA				y					
Dr.R.Viswnathan	Bom.h			y	y	y				
Dr.Chitnis	INDR			y	y			y		
Dr.Bapat	powai									
Mrs.Majumdar	Somaya	y			y			y		
Mrs.Seema	Somya				y			y		
Dr. shivlekar	ilit									
Dr.Mehta	lit.hos.									
Mrs.Chunekar	dwipl		y					y		
Mr.Patil	Himed									
Prof.Mukharji	CSRE									

4.5.2 Expert's Quotes

- "If you can do that nothing like it."
"There is chances of errors due to improper placements in existing system of of test tubes, dishes etc."
- *Dr. Roopa Vishwanathan, Bombay hospitals, Mumbai*
- "Yes it will be useful you can give attachments for settings for different methods.
"Taking care of possible contamination at every stage is very important"
- *Dr. Natrajan, KEM Hospital, Mumbai*
- "*Fully automation system is not always desirable*"
- *Dr. Baweja, KEM Hospital, Mumbai*
- "*Higher automation would mean less job for technicians..*"
- *Technician, KEM, Mumbai*
- "We are using turn table, you can design some hood to protect user."
- *Dr. chumber, AFMC, Pune*
- "It is not convenient to work with the existing mini laminar flow."
- *Dr. sawhany, AFMC, PUNE*
- "High tech look built confidence among patients and workers."
- *Dr. Mahajan, DELTA, Bhopal*
- "Every laboratory would like to purchase if it less then 1lac rupees."
"Lack of discipline is the reason why people are not taking proper safety measures as US or UK"
- *Dr. Tripathi, microbiologist, Bhopal*

4.5.2 Expert's Quotes continued..

- "Such an workstation would be very helpful for us"
- Mrs. Seema, Dept. of microbiology, somaya college, mumbai"
- " using turntable is useful but presently we are working on it outside the hood"
-Dr. Chitnis, Chithram Hosp. & Research centre, Indore
- " There are issues in zone reading, laminar flow, media pouring, sterilization which requires design expertise but turn table is very simple machine"
- " Dispensing systems for disk, dishes,& zone reader are the potential area to work on."
-DR.Nagendra, HOD, Dept. of Microbiology, AFMC, Pune
- There are many example where suitable (high tech, visually striking) looking products were preferred over better technology and functionality.
 - Mr. Sudhir parab, Director, Analytical Automation (I) pvt. Ltd., Mumbai
- "Because of an industrial designer's approach in few year products started looking different and positive results from the markets were quite obvious"
 - » Mrs. Chunekar, Director, Dynamicro (p) ltd.
- "This tests are becoming more and more common nowadays, its good to have product something like this.."
 - » PhD. Student , Biochemistry, IITB

4.5.3 Interpretation of users

- Safety cabinets
 - Safety cabinet's Designs need to be improved..
 - We are not suppose to talk while inoculating..
 - U can provide a screen in front during plating
 - Soon we are planning to have one cabinet..

- Instrumentation
 - Available Disk dispensing equipments does not work properly.
 - using turntable may be useful.
 - we are work outside the laminar flow.

- Process
 - Time is crucial ..should be reduced in some tests it is too high (but it is more of a technology and microbiologists part)
 - Microbiology is the most neglected branch, due to the tedious ness of the media preparation.
 - Less Automation, Fully automation system is not always desirable.
 - Taking care of possible contamination at every stage is very important.

- Cost
 - Since it is a municipal hospital cost can't charge, so can't use expensive methods
 - cost is less then 1 lac everybody will purchase..
 - Stocks method is cumbersome time consuming and costly so we are using kirby bauer disk diffusion method.
(refer annexure VI)

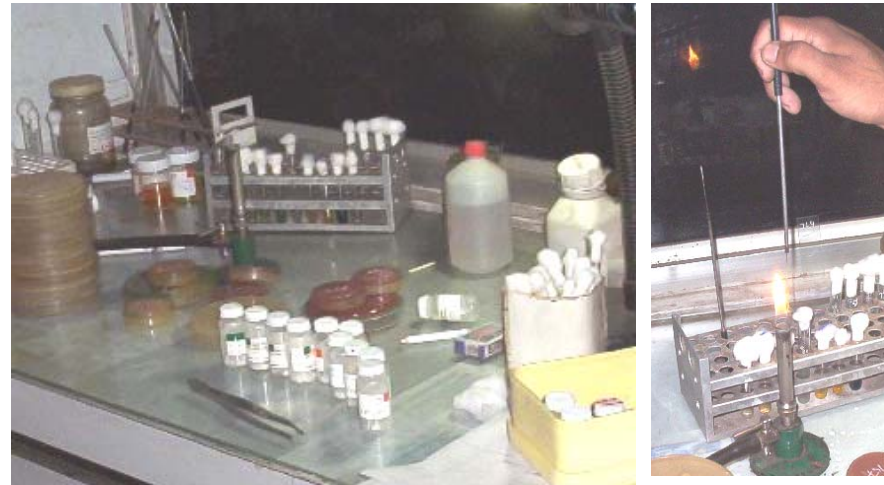
- Operation
 - User wanted that cabinet should be open from the front but contamination is problem
 - I remove the front panel and then I work since it is inconvenient, distance between hand holes is large for me.

- Aesthetics
 - High tech elegant form is also a prime requirement..

4.5.4 Observations

- Most of the equipments are either imported or designed abroad. Locally fabricated equipments are badly designed.
- Unorganized place of working
 - No proper place for keeping /holding things in use during the process.
 - Lot of things with with possible hazardous contents are in use should be disposed e.g. used swabs
 - Visibility and avoidance of likely errors and confusion
 - Spillage of the hazardous contents on the table
 - Problem of visibility of the the test tubes kept at same level.
 - No good solution To check the turbidity /concentration and available instruments are costly.





- In conventional flame burner, for sterilization wire need to be kept for longer time against flame.
- Available Disk dispensers doesn't work properly.
- To see plate every time they hold and tilt it.
- Although user are exposed to hazardous environment safety norms is not practiced in general.
- Women is the majority staff in labs.
- 80-100 test a day in big govt. hospitals



4.5.3 Insights

- Product design for specific purpose, to satisfy regular need.
- Need to Design according to Indian conditions.
- Thirst to look **High tech**
- No availability of organizing devices for during working.
- **users safety** through design.
- Through design regulate Disciplined way of working.

4.5.4 Constraints

- Form of the product and inside Layout of instrumentation should be designed in such a way, that it will not cause any retention, turbulence or vortex of contaminated air inside.
- The laminar flow, of the filtered air, coming from top and passing through the working chamber .
- User should not have to compromise with conventions of working while working on workstation.
- Norms imposed by Authorities and safety measure for biological safety cabinets has to be fulfilled.
(Refer: appendix III, V)
- Optimized Footprint of the products considering lot many labs in India is running in limited space.
- In the process of integrating instruments the dimensions of the workstation should not tamper with the agronomical appropriateness.
- Materials or equipment placed inside the cabinet may cause disruption to the airflow, resulting in turbulence, possible cross-contamination, and/or breach of containment. Extra supplies (e.g., additional gloves, culture plates or flasks, culture media) should be stored outside the cabinet. Only the materials and equipment required for the immediate work should be placed inside.
- **Even with all this technical, usability and safety constraints the product should be elegant, and high tech in its appearance.**

5. Design brief

5. Design brief

Design of a table top workstation for control environment for sample and workers safety in microbiology Lab. Designing for:

- Contents/ Features
 - Close transparent hood with sterile environment to work for one user at a time.
 - Continuous flow of filtered air- HEPA filter with vertical flow.
 - Arrangement for comparing Turbidity.
 - UV or some other light inside for sterility.
 - Turn table for Petri dish plating.
 - Rack and organizing devices for various devices like Petri dish, test tube, sterilizing wires.

- Form
 - High tech looking form.
 - Form to minimize contamination.
 - With the identity of clean, precise.

- Ergonomics
 - Considering Women is the majority staff in labs.
 - Ergonomically correct overall size to work.
 - High degree of visibility in working area
 - Appropriate placing of displays and controls.

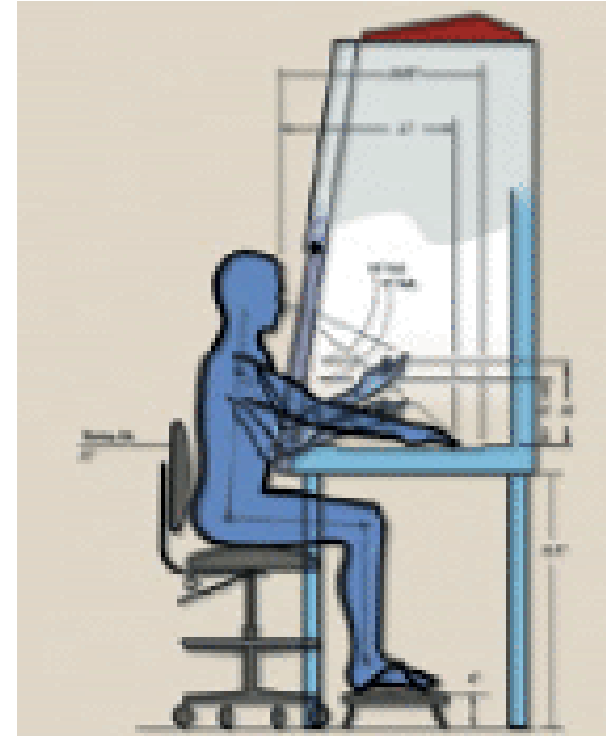
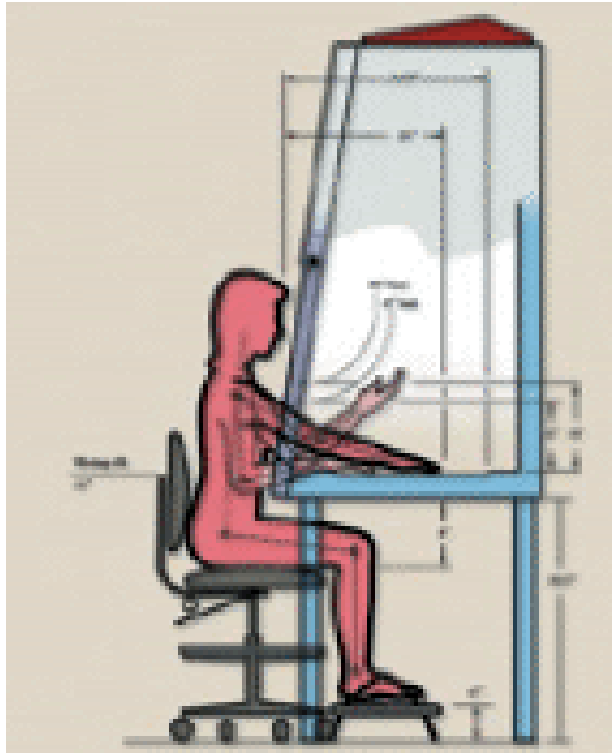
- Material
 - Detachable parts Can withstand temperature of 120 deg. For autoclave.
 - Easy to clean

- Color
 - Color selection should be such that it should not hinder the observation
 - Pleasant to the workers
 - Look clean and neat

6. Design Solution & synthesis, product focus

6.1 Ergonomics

6.1.1 Ergonomics Issues



Refer: www.labconco.com

Issues

- Fatigue and strain that result from working at poorly designed work station
- Irritation of being unable to get physically closer to a project because viewing sash got in the way
- Tension created by working in a cramped work space
- Standard sizes available in India is as per foreign norms, e.g distance between pair of hand holes.
- Higher height percentile might experience upper arm interference with the sash edge set at 8 inches during operations and necessitate lifting the arm or extending the arm into the back region of the work.

6.1.2 Solutions

Solutions

■ Inclined and sliding slash

- Accommodates the slight forward leaning of the upper body , which occurs naturally when laboratory worker perform operations within the cabinet.
- The front panel inclined minimum by 10 degree will permits flexibility rather than rigid movements of the upper torso and head without compromising desired posture standard and thus preventing neck and back strain
- A further benefit accrues to the laboratory worker as a result of the angled sash. The reflection of the laboratory lighting upon the glass of the vertical sash of a bio safety cabinet can cause glare. Interfering with the worker's view of operations within the cabinet
- The curved air foil is comfortable for the user and features reserve –Air secondary airflow slots in the front of the grille to ensure safe airflow even when the grill may be in advertently blocked by the user.

■ Controls

- The controls of the bio safety cabinets are commonly located on the upper fascia, necessitating extreme extension of the neck and flexion of the shoulder joint for operational visibility and reach.
- Controls are to be mounted in the user's field of vision to limit neck movement.
- Comfortable access to the service fixtures with his/her back supported by the chair while naturally raising the upper arm to operate the valve.
- By locating pressure gauge in the lower region of the interior back wall, safety cabinet provide optimum visibility of the gauge.

■ Interior

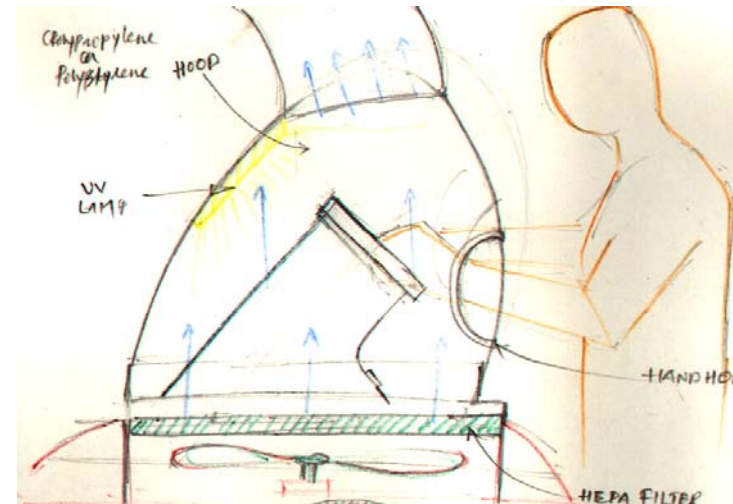
- Strain reduction by size and interior of the cabinet.
- Increase the work area of the user without contributing to the shortage of the space that exist within most laboratories.

Concept Generation

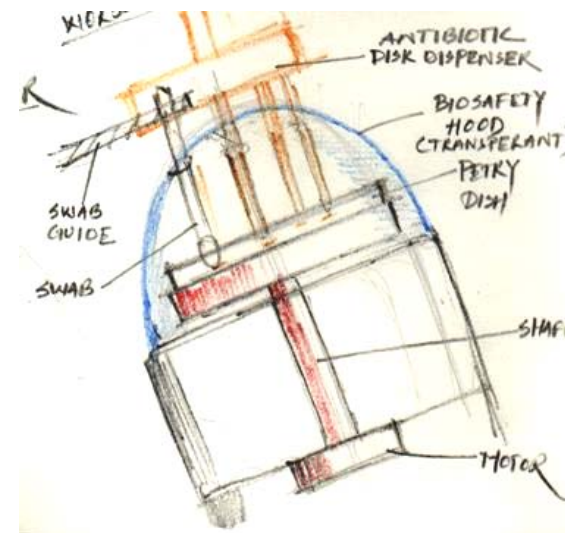
6.2 Concept Generation

6.2.1 Initial concepts

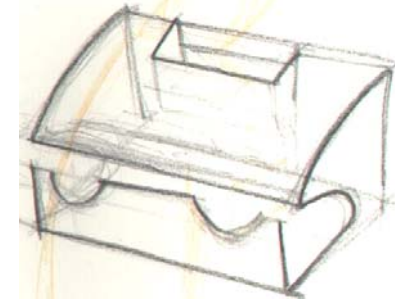
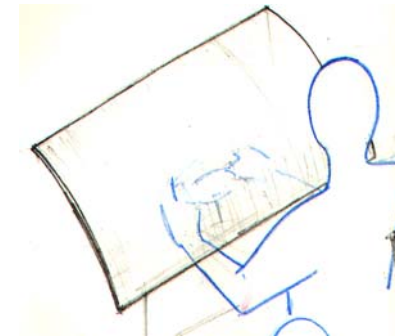
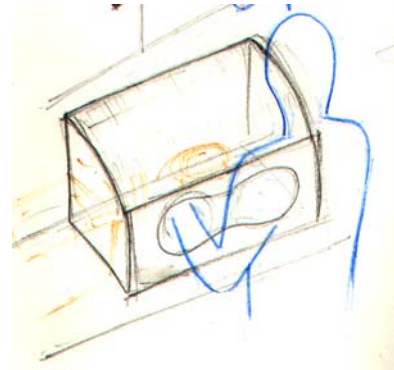
- Initial sketches made during understanding of project idea and during data collection and user survey.
- Suggestions, requirements, observations and insights were in general directly incorporated in to the sketches.



- Such as in the shown ideas.
 - E.g., Enclosure with all attachments outside were conceived, shown in figure.

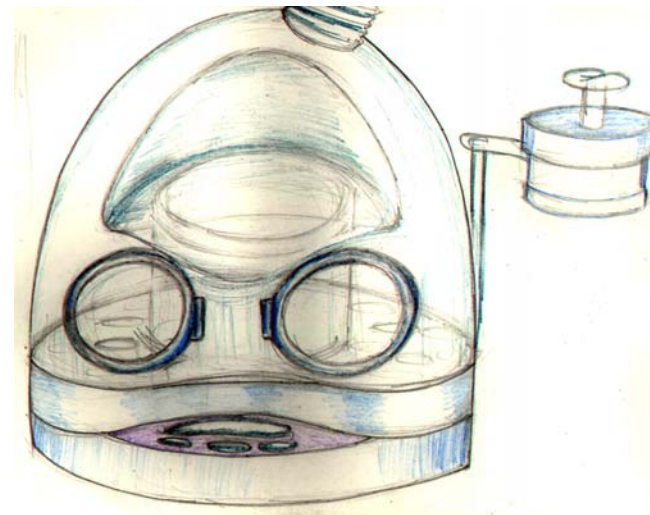
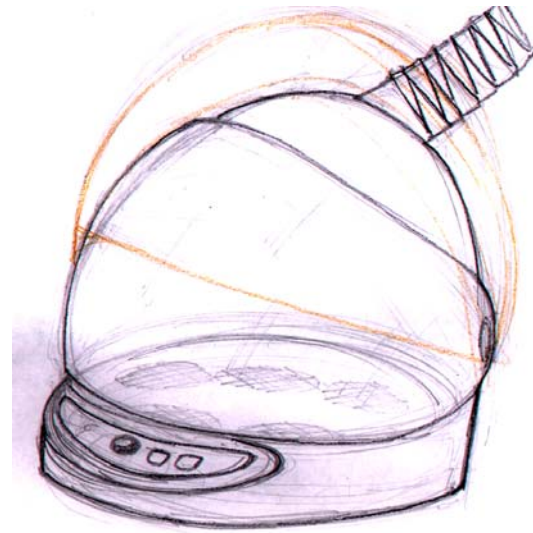


6.2.1 Initial concepts continued..



- Minimalist approach & simple form, options with
 - A single molded screen
 - A simple close hood With built in of hand support and temporary holding and support for instruments.

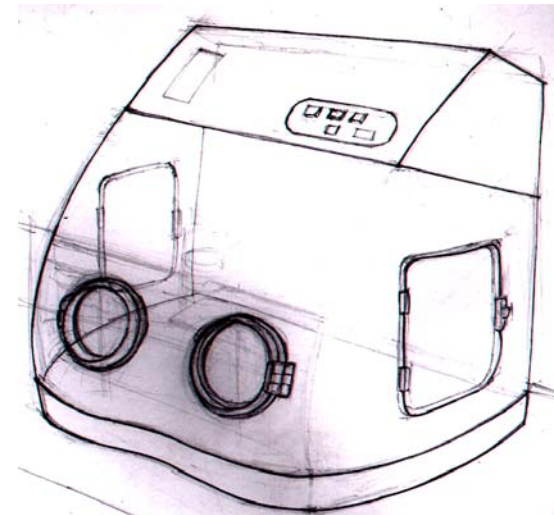
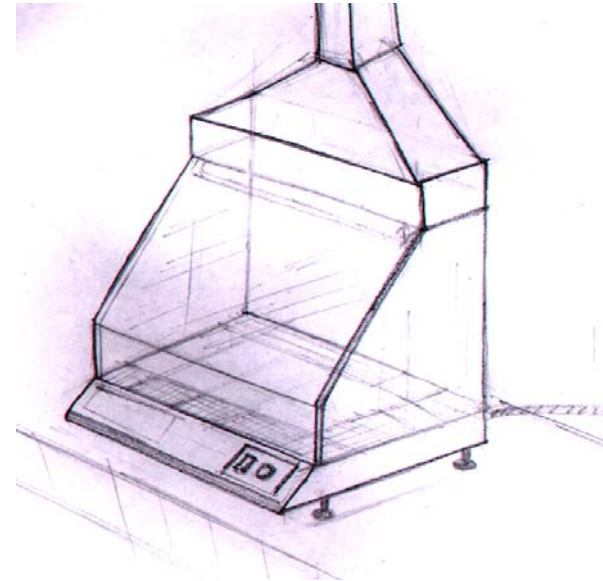
6.2.1 Initial concepts continued..



- Inspired by form and function (protection) of helmet, because of its modern look and function of workstation is also to protect, direct analogy

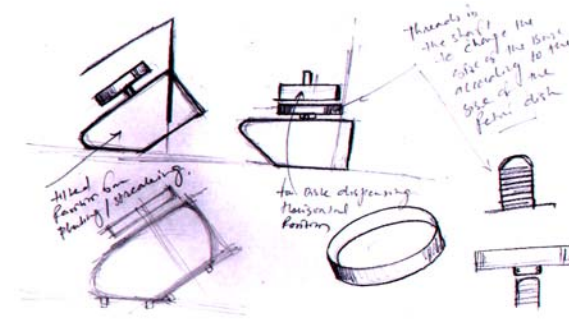
6.2.1 Initial concepts continued..

- Bold straight lines with emphasis on function, e.g. placing of control and tilted front glass panel for better visibility.
- Form with more of functional, cohesive and integrated approach.

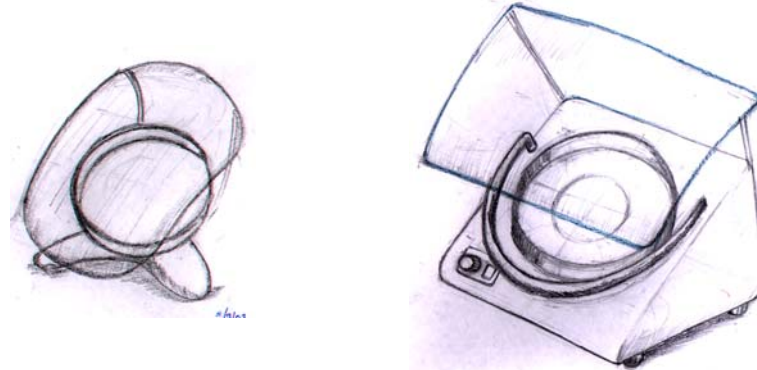


6.2.1 Initial concepts continued..

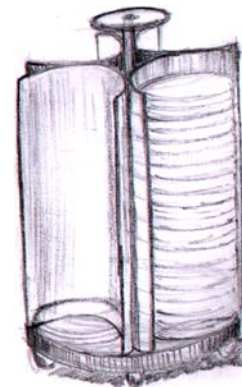
- Initial Ideas for designing various components
 - User does not hold petri dish horizontal it is in angle, so concepts for turn table with tilting arrangement.



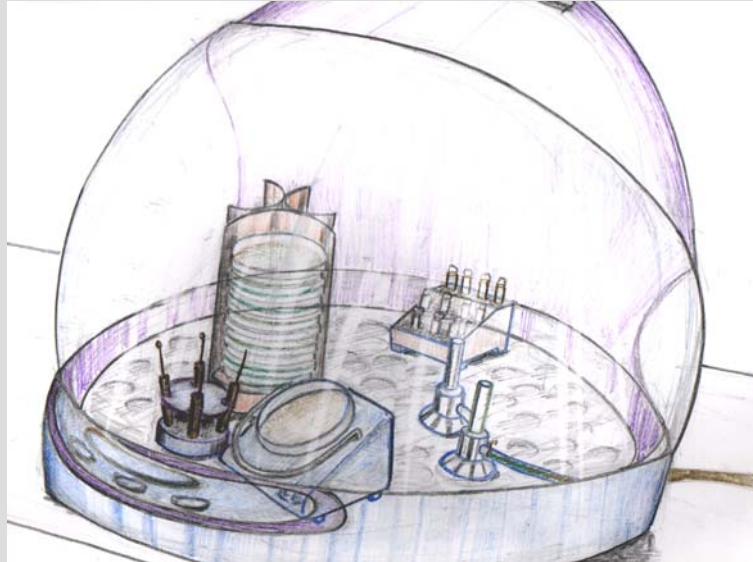
- With protective glass shield



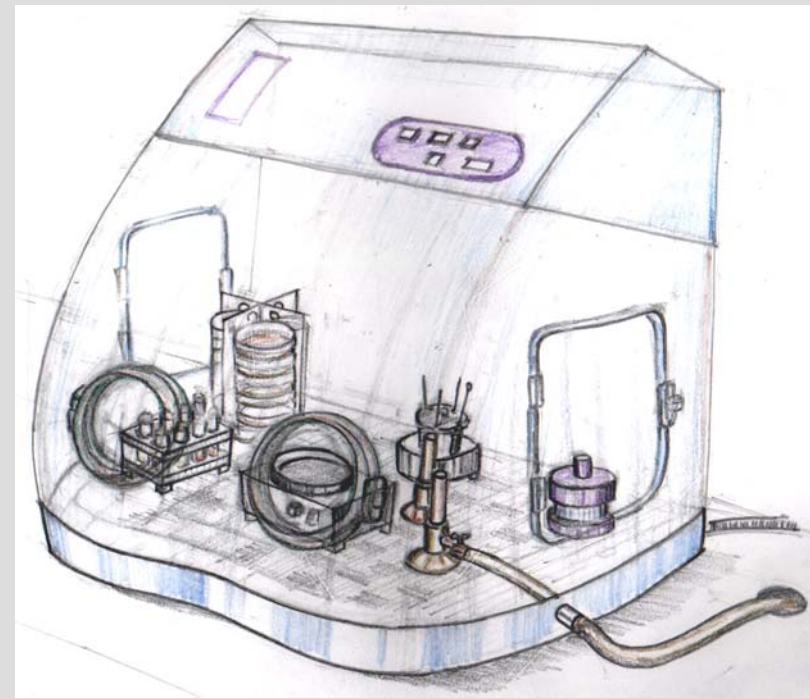
- Stand for Holding & dispensing of petri dish



6.2.1 Initial concepts continued..



- With the segregated approach, each component with distinct entity
- Based on two initial concepts That overall arrangement Inside the cabinet were drawn to understand relationship between each other.



Final Concept Generation

6.2.2 Final Concept Generation

6.2.2 Final Concept Generation

Based on collected data, constrains, design brief and initial concept sketches made during data collection, further concept generation process were started.

Form

it is a product for medical use where Patients comes with a trust and hope.

■ Attributes for form generation:

- High tech:
 - abstruse, baroque, Byzantine, complex, convoluted, daedal, difficult, elaborate, entangled, fancy, hard, intricate, involved, knotty, labyrinthine, obscure, perplexing, rococo, snake pit, sophisticated, tortuous, tricky, untangled
- honest
- Precise
- Reliable
- Straight forward
- Clean
- Neat
- serious





- Compartmentalization
 - Semantically compartmentalize the interior and exterior.
- Integration
 - integrate grating the physical entity of the instruments, equipments and even process, as much as possible, into a form , consideration of existing or possible :
 - New products
 - New technology

6.2.2 Final Concept Generation continued..

Function

Some of the initial concepts made, were ruled out, since they were not feasible, but they become the base for the further final concept development :

- enclosures:
 - How to protect it from environment contamination
 - Safety cabinet, laminar flow or simply a hood?
 - UV light, fumigation for sterility and other lighting inside to work.
 - Close transparent hood with sterile condition inside.
 - HEPA filter with vertical flow.

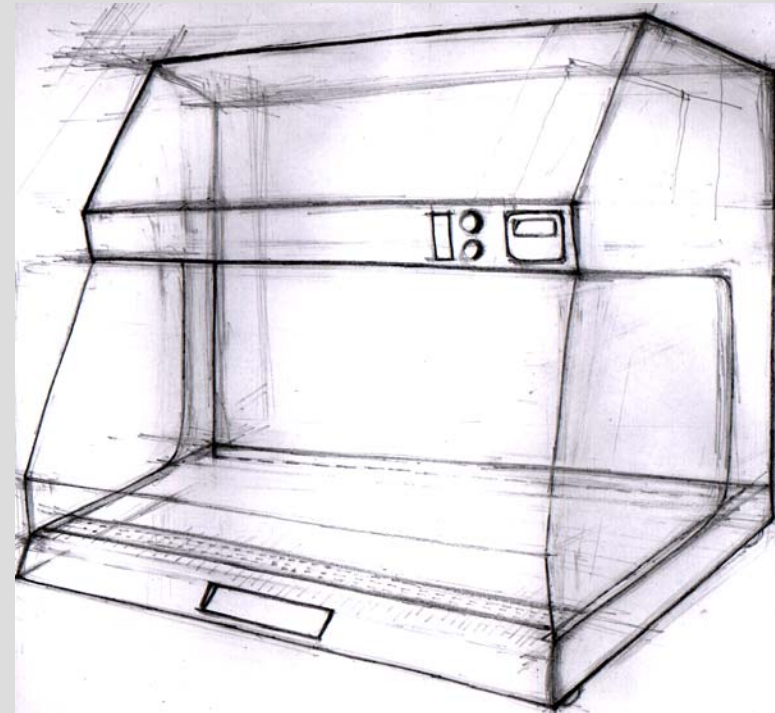
- Internal Components
 - Turn table for Petri dish plating.
 - Rack and organizing devices for various devices like Petri dish, test tube, sterilizing wires.
 - Turbidity meter: Arrangement for comparing Turbidity.
 - Antibiotic medicine chart with the system.

- Controls
 - Appropriate form and placing of switches, displays aesthetically and functionally.

- maintenance
 - Cleaning and sterilization issues by making them fixed or detachable.
 - Appropriate fillet radius, avoiding sharp corners.



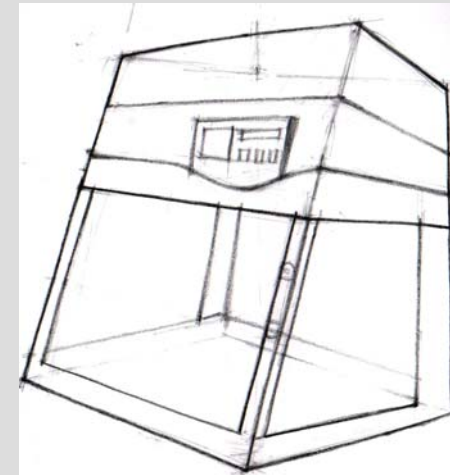
6.2.2 Final Concept Generation continued..



- Straight forward form with bold straight lines with emphasis on functional convenience and constraints
 - placing of control and angled front glass panel for better visibility and ease of operation, data based on chapter 6.1 ergonomics
 - Straight edges for precise and serious appearance of the product
 - Getting the right proportions

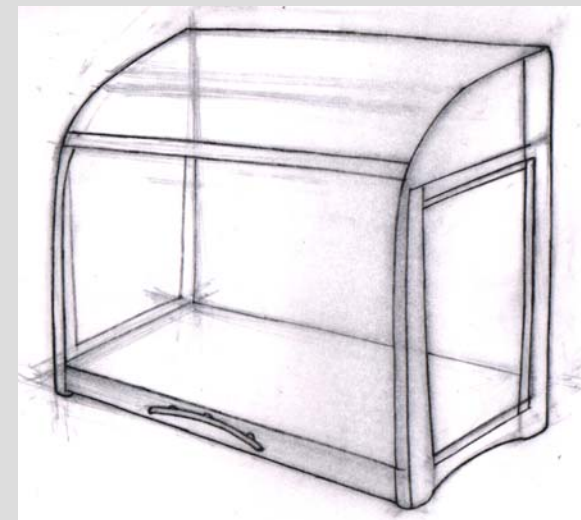
6.2.2 Final Concept Generation continued..

- With the extension of the previous concept of straight bold lines an experiment to have slant surfaces at front, right, left sides to add dramatic appearance in addition to precise and serious appearance of the product.

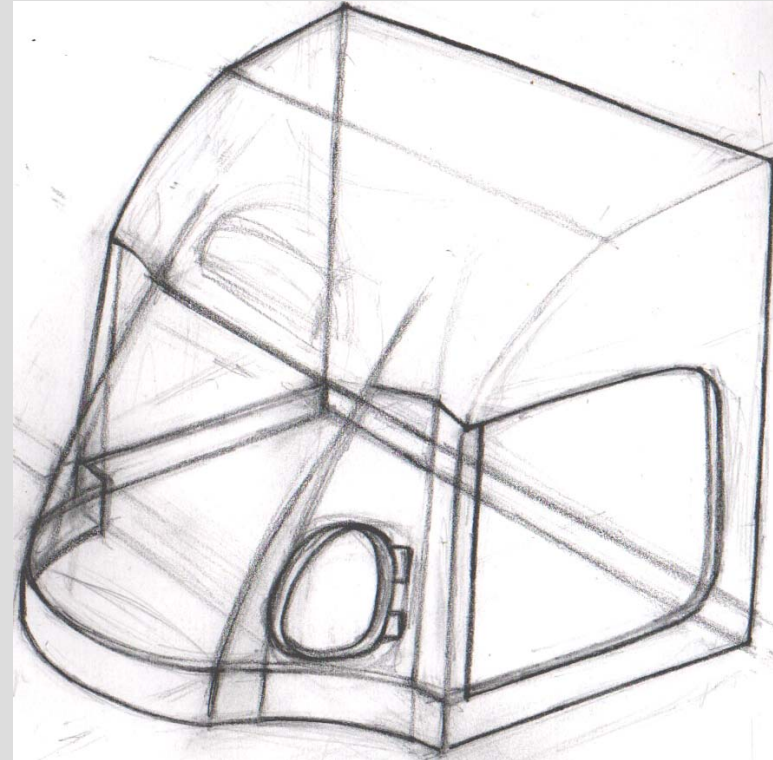


- Keeping similar approach of straightness, with large curves at side face of the corners in structure and prominent curvature at front up for

- contemporary look
- Integrating the front glass and top structure in a single uniform and dynamic flow to get the elegance in the form.

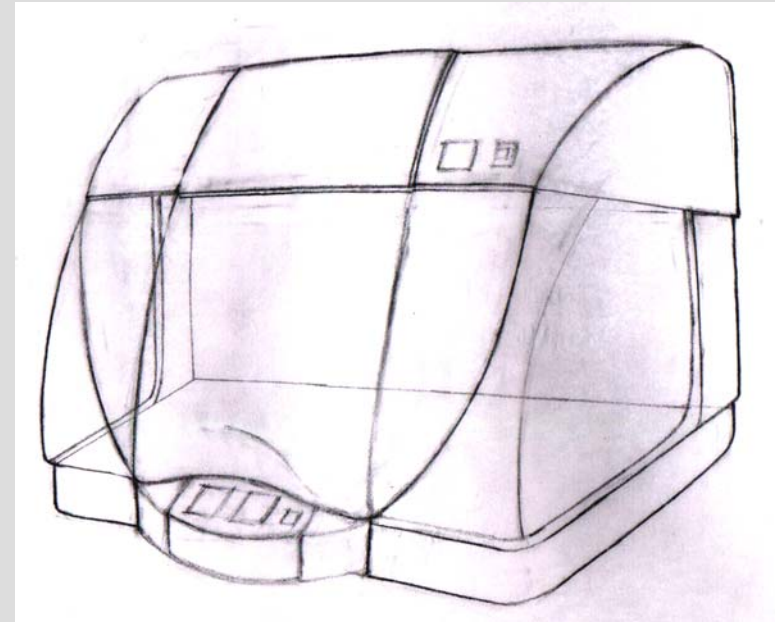


6.2.2 Final Concept Generation continued..



- Compartmentalization according to the operation to be performed inside.
- Semantically defining the function
- Most active Middle portion with two side areas for temporary storage.
- Hand hole pair is at an angle, since projected Middle Part is nearest to the user's chest.

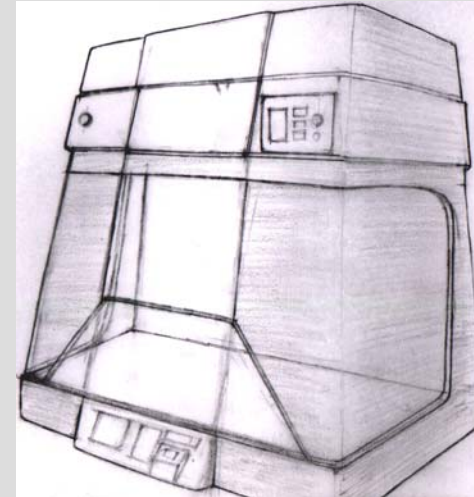
6.2.2 Final Concept Generation continued..



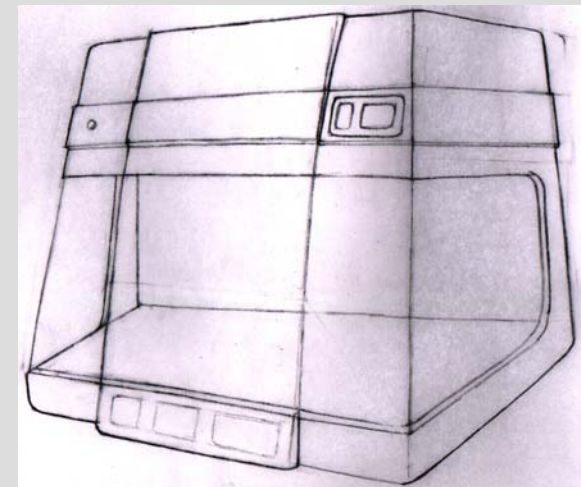
- With the extension of compartmentalization approach, from the last form cohesiveness and overall integration in to the form were tried to brought in.
- flowing curves for contemporary and user friendly appearance, for sophisticated look with all corners filleted with large radius.
- Dynamic form to convey, fast operating for fast results.
- Middle placement of the the control on front of the base for easy. accessibility and attention while operating.

6.2.2 Final Concept Generation continued..

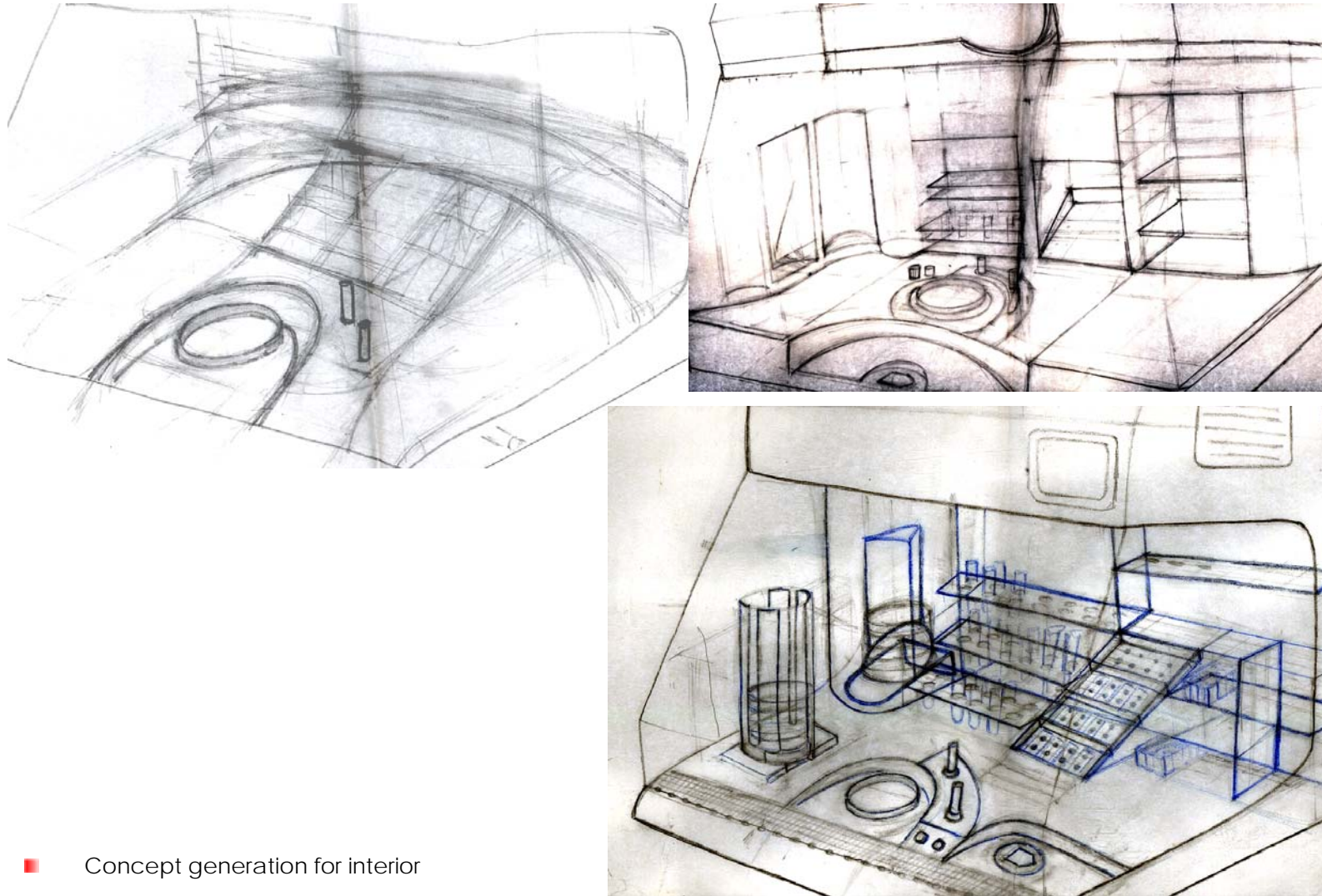
- Integrated one piece acrylic shield with hand cut out
- Change in proportion from last concept.



- Compartmentalization according to the operation in straight & bold lines with little high fillets.
- Semantically defining the function from outer form.
- Most active Middle portion with two side areas for temporary storage.
- Middle front placement of controls for frequent operation during work.
- Occasional control at upper right.
- Projection area at upper portion to high light controls and graphics.

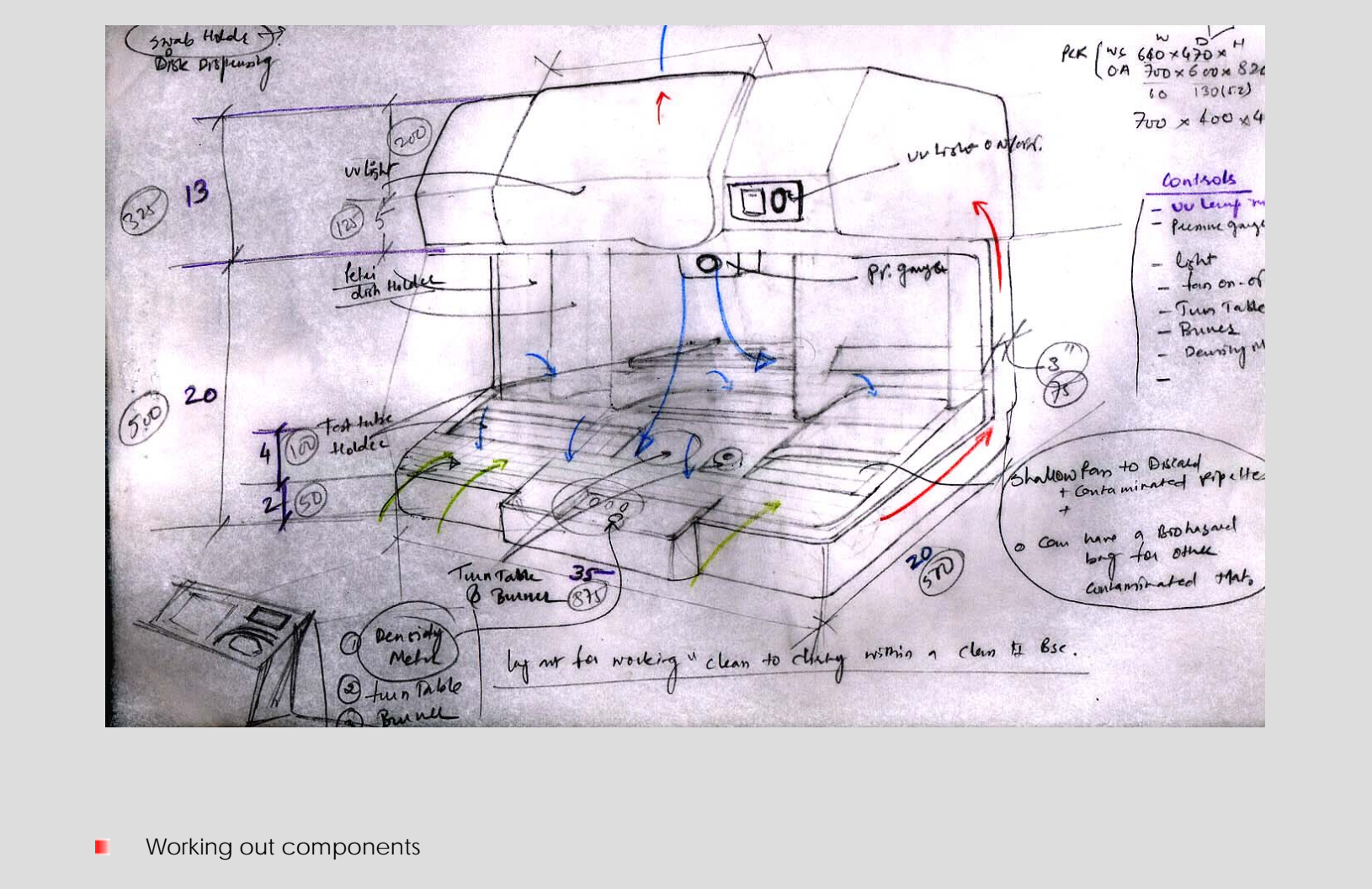


6.2.2 Final Concept Generation continued..



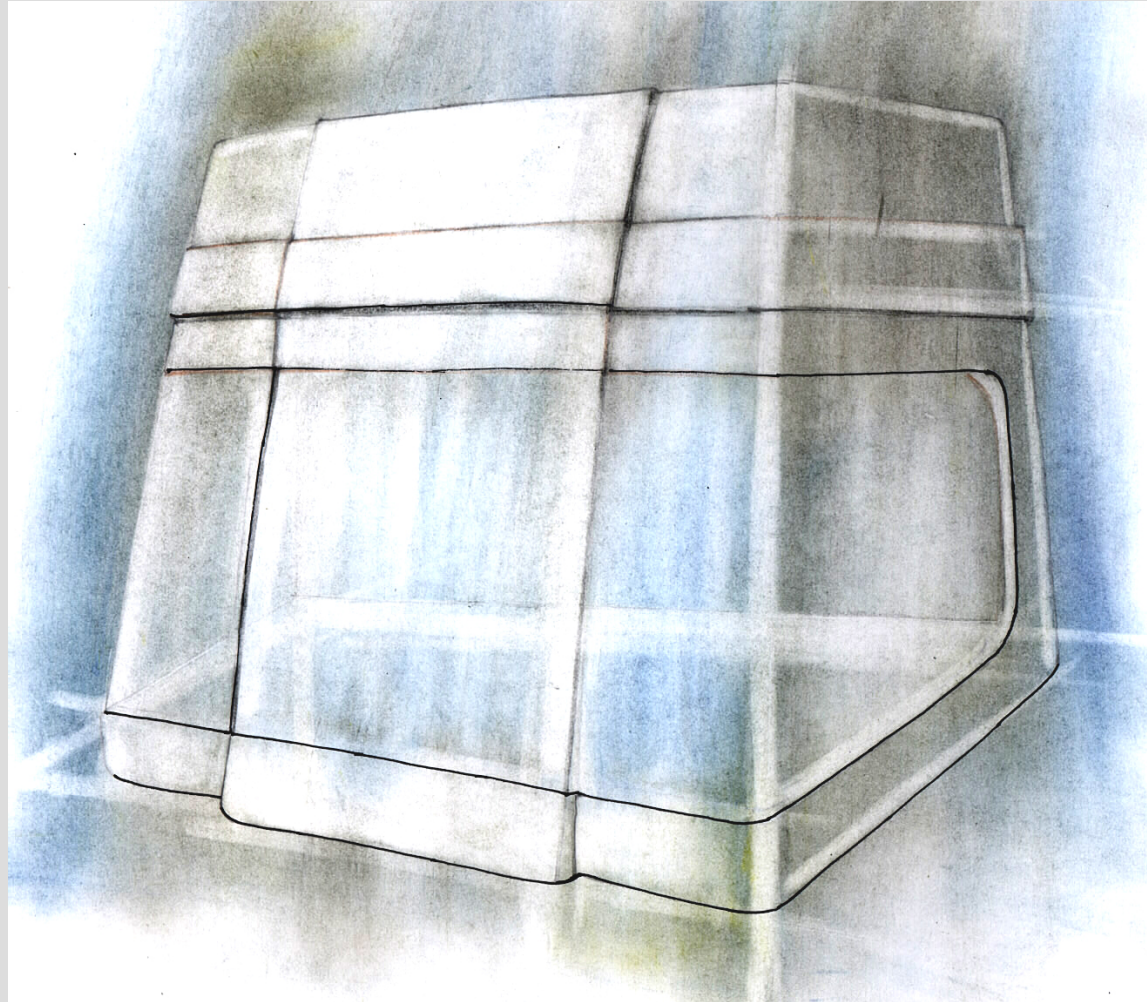
■ Concept generation for interior

6.2.2 Final Concept Generation continued..



Working out components

6.2.2 Final Concept Generation continued..



6.2.2 Final Concept Generation continued..

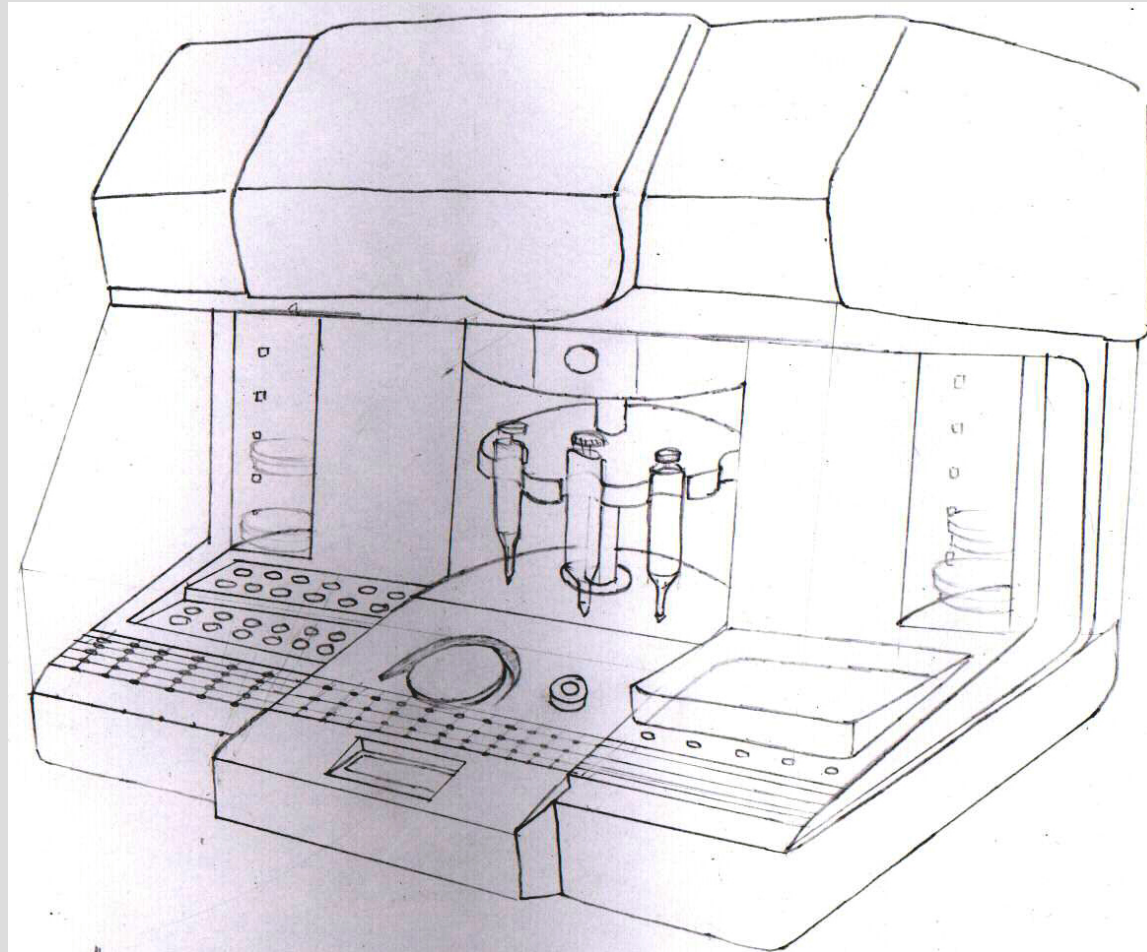
Exterior

- Angled sash, Straight fall (slant) of front from top to bottom.
- Semantically defining the segments from outer form.
 - Compartmentalization according to the operation with little level difference (projection) on the cabinet.
 - Most active Middle portion with two side areas for temporary storage.
- Frequently operated controls during work are Placed at lower- Middle- front on angled plane, Occasional control at upper right corner.
- Projected area running all along cross sectional at upper portion to high light controls and graphics and to break the monotony of the front fall.

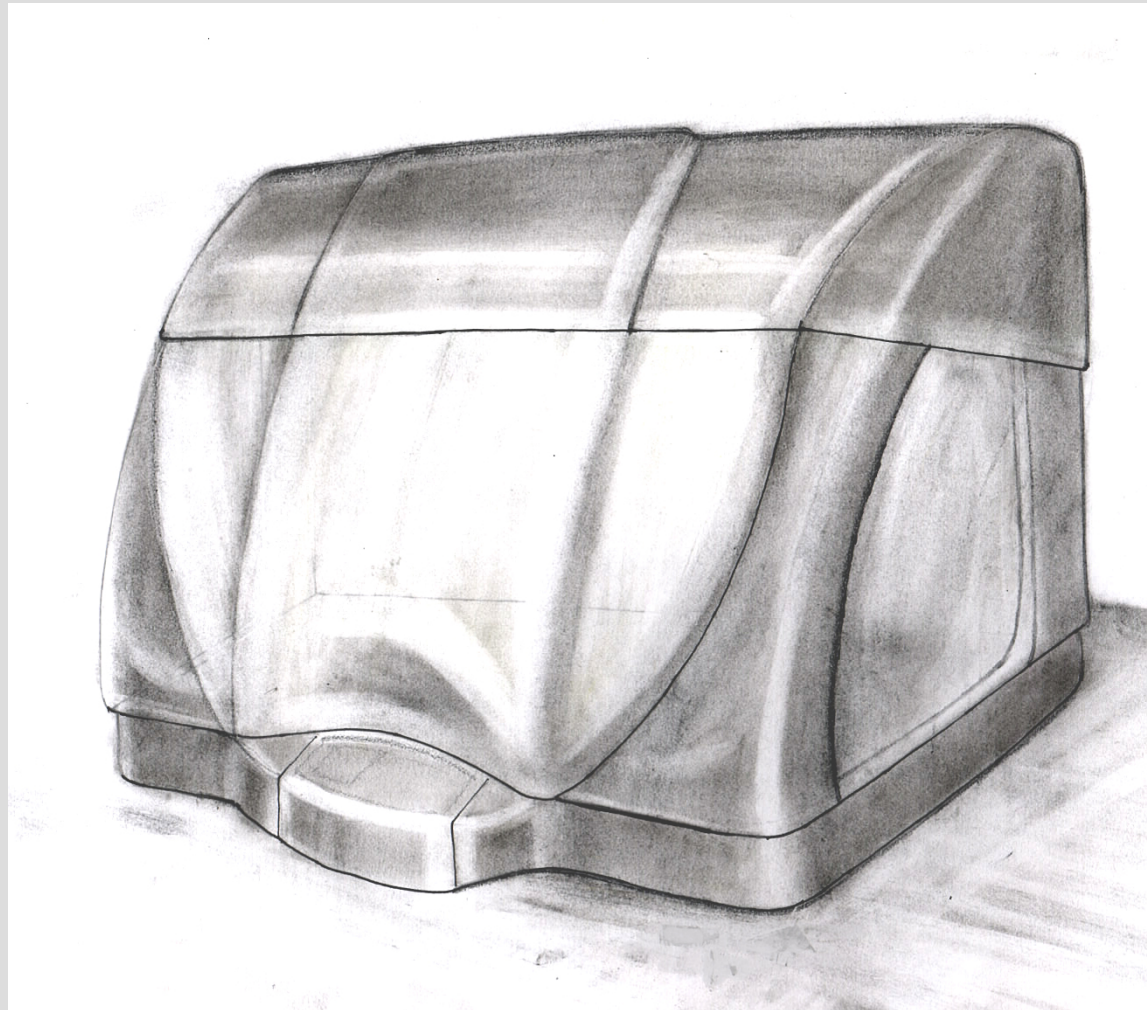
Interior

- molded plate fitted in angle for
 - better viewing and handling of Test tubes, slides which will be well visible since gradual increment in height.
 - Facilitate Accommodation of the instruments, connecting, wires etc. below this plate.
 - The curved air foil is comfortable for the user and features air flow slots.
- Making Accessories build in , Integral part of the surfaces.
- Center location on base plate consist Turn table located at middle with electric loop sterilizer at one side.
- At center back revolving wheel for Hanging pipettes, sterilizing wire etc. during operation.
- Petri dish dispenser and holders at extremes of cabinet for respectively keeping new and finished separately.
- Adjacent to the back wall accessories for holding and dispensing of petri dish, pipettes and a pressure gauge.
- A typical layout for working "clean to dirty". Clean cultures placed at left side of the user can be inoculated center that is petri dish zone ,contaminated pipettes, swab, test tubes etc. can be discarded in the shallow closed pan and other contaminated materials. (Refer Annexure I)

6.2.2 Final Concept Generation continued..



Final Concept Generation



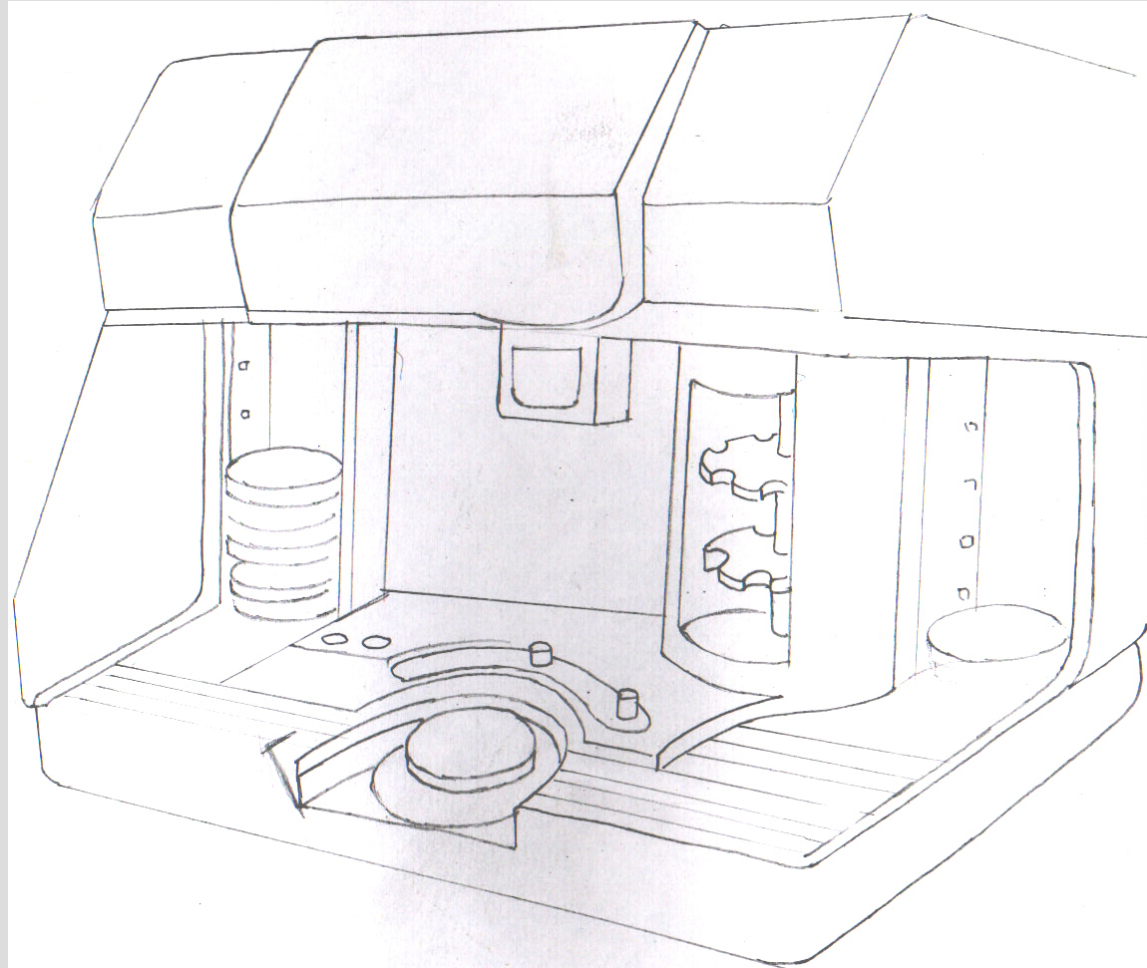
6.2.2 Final Concept Generation continued..

- Compartmentalization of the form according to function to bring Continuity, cohesiveness and overall integration in to the form.
- Elegantly flowing curves, with all corners filleted with large radius for contemporary and user friendly, sophisticated look.
- Dynamic form to convey that it is for fast results.
- Angled placement of the the control at middle part on base plate for easy accessibility and attention while operating.
- Elegant Overall integration of the interior and exterior with functional and aesthetical goals with constraints.

Interior

- molded plate fitted in angle for
 - better viewing and handling of Test tubes, slides which will be well visible since gradual increment in height.
 - Facilitate Accommodation of the instruments, connecting, wires etc. below this plate.
 - The curved air foil is comfortable for the user and features air flow slots.
- Making Accessories build in , Integral part of the surfaces.
- Middle front location consist Turn table with add on feature of a sliding cover which can be pulled out to cover the top of the turn table to get the flat surface on top.
- 2 electric loop sterilizer above in circular form.
- At right half 2 revolving wheels for Hanging pipettes, sterilizing wire etc. during operation.
- Petri dish dispenser and holders at extremes back corners of cabinet for respectively, keeping new and finished ones separately.
- Adjacent to the back wall accessories for holding and dispensing of petri dish, pipettes and a pressure gauge.
- A typical layout for working "clean to dirty". Clean cultures placed at left side of the user can be inoculated center that is petri dish zone ,contaminated pipettes, swab, test tubes etc. can be discarded in the shallow closed pan and other contaminated materials. (Refer Annexure I)

6.2.2 Final Concept Generation continued..



6.2.2 Final Concept Generation

Concept 1



6.2.2 Final Concept Generation continued..

- On the platform of Straight forward, bold straight lines all possible functional convenience and constraints, the form was further refined
 - placing of control and angled front glass panel for better visibility and ease of operation, data based on chapter 6.1 ergonomics.
 - Straight edges for precise and serious appearance of the product with delicate fillets all over with required radius variation.
 - Possible Right proportions.
 - With grooves and projection on front upper part and transparent sash and panel semantically defining
 - Compartmentalization according to the function
 - Breaking the monotony
 - Elegant Overall integration of the interior and exterior with functional and aesthetical goals with constraints.

Interior

- molded plate fitted in angle for
 - better viewing and handling of Test tubes, slides which will be well visible since gradual increment in height.
 - Facilitate Accommodation of the instruments, connecting, wires etc. below this plate.
 - The curved air foil is comfortable for the user and features air flow slots.
- Making Accessories build in , Integral part of the surfaces.
- Center location consist Turn table located at middle with electric loop sterilizer at one side.
- Two adjacent Petri dish dispenser and holders at left extremes.
- Adjacent to the back wall accessories for holding test tubes pipettes and a pressure gauge.
- A typical layout for working "clean to dirty". Clean cultures placed at left side of the user can be inoculated center that is petri dish zone ,contaminated pipettes, swab, test tubes etc. can be discarded in the shallow closed pan and other contaminated materials. (Refer Annexure I)

6.3 Material

Few Possible options, are:

- Front transparent screen,
 - Acrylic offers versatile economical alternative
 - Easily retrofitted
 - Visibility
 - Light weight
 - Clear acrylic panels

- Racks, plates, storage, dispenser..
 - Acrylic racks can be used to conveniently and safely stack or store Petri dishes.
 - Epoxy coated steel wire for petri dish dispenser.
 - polycarbonate

- Tray
 - FIBERGLASS TRAY, nonporous surface Resistant to acids, weak alkali, and many chemicals Temperature tolerance -60 to 250oC
 - Trays - Injection molded from virgin biomedical grade polystyrene crystal.
 - Polypropylene tray , steam autoclavable and resistant to temperatures up to 135 C.
 - Seamless stainless steel medical/laboratory trays with coved corners for easy sterilization.

- Cabinet , Side panels
 - 316 stainless steel
 - epoxy coated zintec steel
 - polycarbonate

- Work surface
 - Perforated 316 grade stainless steel Spillage tray: 316
 - Type 304 stainless steel substructure.
 - Unitized 16-gauge stainless steel substructure.

- Turn Table
 - Contact surface is covered with nonskid material to grip the plate.

7. Market Placement

- This product can be placed at unique position, where it can satisfy the requirement of both big and small laboratories (by quantum of samples). Since this a workstation for one user, if user increases according to the requirement, as in the case of big laboratories, The compact design allows multiple units to be placed side-by-side to create one continuous run of work space.
- Cost of the product can be easily justified with the Facilities and instrumentation integrated in the product, which otherwise would individually cost substantially high.

8. postscript

- There is always been a gap between the safety norms and discipline been practiced and should be followed, particularly in India this gap is large, there could be many reason for that but it is for sure that one of them is non availability of well designed products as per the local conditions here.
- There are very few manufacturers/ producer and out of them, hardly any, who design their own products, many ultimately work as an supplier of some foreign companies placed at Europe or US.
- Diagnostic sector has much human intervention at every stage, products with industrial designer touch will definitely help to make patient and user's life easy and safe, also with creating safety environmental.
- When I started with the project, I was not aware of such extensive need of industrial designers approach in this area. Later I realize, enormous design potential exist, for modifying and identifying new products. This design potential should be seen as an opportunity by the designers.
- I feel there is always a scope of further improvement in design of the products; it is optimization process from the user interpretation.

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- **EQUIPMENT FOR A MICROBIOLOGY WORK STATION**
 - ©David B. Fankhauser, Ph.D.,
Professor of Biology and Chemistry
University of Cincinnati Clermont College,
Batavia OH 45103
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Glossary

- HEPA : High efficiency particulate air
- BSC - biological safety cabinet
- Broth - liquid media
- Turbidity - haziness
- Inoculation - seeding bacteria
- Incineration- burning for safe disposal

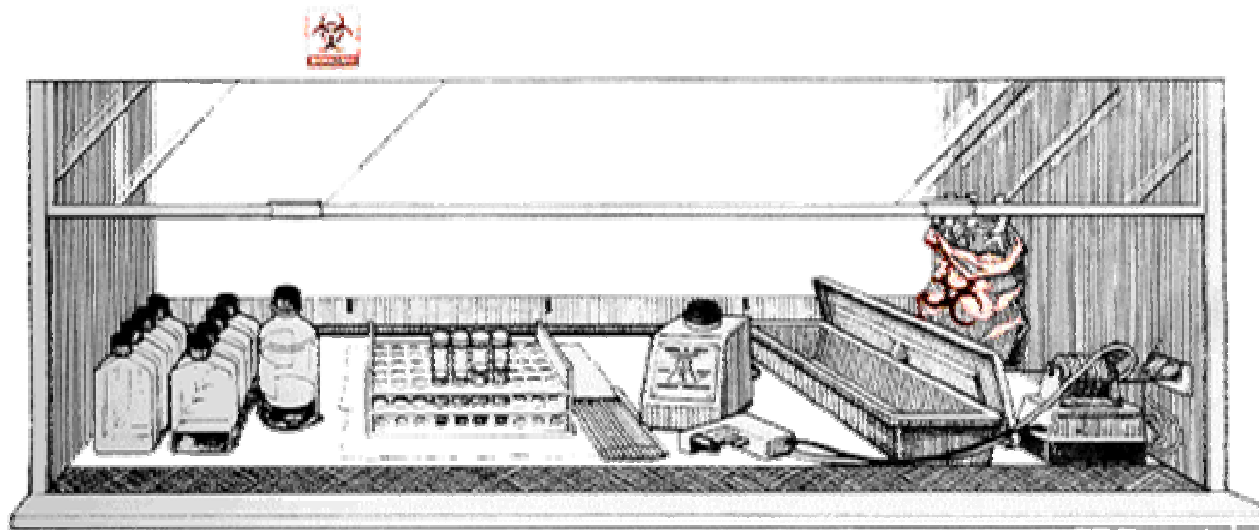
Appendices

Appendices

- Preparing a written checklist of materials necessary for a particular activity and placing necessary materials in the BSC before beginning work serves to minimize the number of arm-movement disruptions across the fragile air barrier of the cabinet. The rapid movement of a worker's arms in a sweeping motion into and out of the cabinet will disrupt the air curtain and may compromise the partial barrier containment provided by the BSC. Moving arms in and out slowly, perpendicular to the face opening of the cabinet, will reduce this risk. Other personnel activities in the room (e.g., rapid movement, open/closing room doors, etc.) may also disrupt the cabinet air barrier (5). Laboratory coats should be worn buttoned over street clothing; latex gloves are worn to provide hand protection. A solid front, back-closing lab gown provides better protection of personal clothing than a traditional lab coat. Gloves should be pulled over the knitted wrists of the gown, rather than worn inside. Elasticized sleeves can also be worn to protect the investigator's wrists.
- Before beginning work, the investigator should adjust the stool height so that his/her face is above the front opening. Manipulation of materials should be delayed for approximately one minute after placing the hands/arms inside the cabinet. This allows the cabinet to stabilize and to "air sweep" the hands and arms to remove surface microbial contaminants. When the user's arms rest flatly across the front grille, room air may flow directly into the work area, rather than being drawn through the front grille. Raising the arms slightly will alleviate this problem. The front grille must not be blocked with research notes, discarded plastic wrappers, pipetting devices, etc. All operations should be performed at least four "4" inches from the front grille on the work surface.
- Materials or equipment placed inside the cabinet may cause disruption to the airflow, resulting in turbulence, possible cross-contamination, and/or breach of containment. Extra supplies (e.g., additional gloves, culture plates or flasks, culture media) should be stored outside the cabinet. Only the materials and equipment required for the immediate work should be placed in the BSC.
- BSCs are designed to be operated 24 hours per day, and some investigators find that continuous operation helps to control the laboratory's level of dust and other airborne particulates. Although energy conservation may suggest BSC operation only when needed, especially if the cabinet is not used routinely, room air balance is an overriding consideration. In some instances, room exhaust is balanced to include air discharged through ducted BSCs.
- Cabinet blowers should be operated at least three to five minutes before beginning work to allow the cabinet to "purge". This purge will remove any particulates in the cabinet. The work surface, the interior walls (not including the supply filter diffuser), and the interior surface of the window should be wiped with 70% ethanol (EtOH), a 1:100 dilution of household bleach (i.e., 0.05% sodium hypochlorite), or other disinfectant as determined by the investigator to meet the requirements of the particular activity. When bleach is used, a second wiping with sterile water is needed to remove the residual chlorine, which may eventually corrode stainless steel surfaces. Wiping with non-sterile water may recontaminate cabinet surfaces, a critical issue when sterility is essential (e.g., maintenance of cell cultures).
- Similarly, the surfaces of all materials and containers placed into the cabinet should be wiped with 70% ETOH to reduce the introduction of contaminants to the cabinet environment. This simple step will reduce introduction of mold spores and thereby minimize contamination of cultures. Further reduction of microbial load on materials to be placed or used in BSCs may be achieved by periodic decontamination of incubators and refrigerators.
- Source: <http://www.orcbs.msu.edu/biological/bsc/section5.htm>

Material Placement Inside the BSC

Appendix II



- Plastic-backed absorbent toweling can be placed on the work surface (but not on the front or rear grille openings). This toweling facilitates routine cleanup and reduces splatter and aerosol formation (3) during an overt spill. It then can be folded and placed in an autoclavable biohazard bag when work is completed. All materials should be placed as far back in the cabinet as practical, toward the rear edge of the work surface and away from the front grille of the cabinet (Figure 11). Similarly, aerosol-generating equipment (e.g., vortex mixers, tabletop centrifuges) should be placed toward the rear of the cabinet to take advantage of the air split described in Section III. Active work should flow from the clean to contaminated area across the work surface. Bulky items such as biohazard bags, discard pipette trays and suction collection flasks should be placed to one side of the interior of the cabinet.
- Certain common practices interfere with the operation of the BSC. The autoclavable biohazard collection bag should not be taped to the outside of the cabinet. Upright pipette collection containers should not be used in BSCs nor placed on the floor outside the cabinet. The frequent inward/outward movement needed to place objects in these containers is disruptive to the integrity of the cabinet air barrier and can compromise both personnel and product protection. Only horizontal pipette discard trays containing an appropriate chemical disinfectant should be used within the cabinet. Furthermore, potentially contaminated materials should not be brought out of the cabinet until they have been surface decontaminated. Alternatively, contaminated materials can be placed into a closable container for transfer to an incubator, autoclave or for other decontamination treatment.
- Source : <http://www.orcbs.msu.edu/biological/bsc/section5.htm>

- **Laboratory Hazards** Many common procedures conducted in BSCs may create splatter or aerosols. Good microbiological techniques should always be used when working in a biological safety cabinet. For example, techniques to reduce splatter and aerosol generation will minimize the potential for personnel exposure to infectious materials manipulated within the cabinet. Class 11 cabinets are designed so that horizontally nebulized spores will be captured by the downward flowing cabinet air within fourteen inches (24) of travel. Therefore, as a general rule of thumb, keeping clean materials at least one foot away from aerosol-generating activities will minimize the potential for cross-contamination.
- The general work flow should be from "clean to contaminated (dirty)" ([see Figure 11](#)). Materials and supplies should be placed in such a way as to limit the movement of "dirty" items over "clean" ones.
- Several measures can be taken to reduce the chance for cross-contamination when working in a BSC. Opened tubes or bottles should not be held in a vertical position. Investigators working with Petri dishes and tissue culture plates should hold the lid above the open sterile surface to minimize direct impaction of downward air. Bottle or tube caps should not be placed on the towel. Items should be recapped or covered as soon as possible.
- Open flames are not required in the near microbe-free environment of a biological safety cabinet. On an open bench, flaming the neck of a culture vessel will create an upward air current which prevents microorganisms from falling into the tube or flask. An open flame in a BSC, however, creates turbulence which disrupts the pattern of air supplied to the work surface. When deemed absolutely necessary, touch-plate microburners equipped with a pilot light to provide a flame on demand may be used. Internal cabinet air disturbance and heat buildup will be minimized. The burner must be turned off when work is completed. Small electric "furnaces" are available for decontaminating bacteriological loops and needles and are preferable to an open flame inside the BSC. Disposable sterile loops can also be used.
- Aspirator bottles or suction flasks should be connected to an overflow collection flask containing appropriate disinfectant, and to an in-line HEPA or equivalent filter ([see Figure 12](#)). This combination will provide protection to the central building vacuum system or vacuum pump, as well as to the personnel who service this equipment. Inactivation of aspirated materials can be accomplished by placing sufficient chemical decontamination solution into the flask to kill the microorganisms as they are collected. Once inactivation occurs, liquid materials can be disposed of appropriately as noninfectious waste.
- Investigators must determine the appropriate method of decontaminating materials that will be removed from the BSC at the conclusion of the work. When chemical means are appropriate, suitable liquid disinfectant should be placed into the discard pan before work begins. Items should be introduced into the pan with minimum splatter, and allowed appropriate contact time as per manufacturer's instructions. Alternatively, liquids can be autoclaved prior to disposal. Contaminated items should be placed into a biohazard bag or discard tray inside the BSC. Water should be added to the bag or tray prior to autoclaving.
- When a steam autoclave is to be used, contaminated materials should be placed into a biohazard bag or discard pan containing enough water to ensure steam generation during the autoclave cycle. The bag should be taped shut or the discard pan should be covered in the BSC prior to removal to the autoclave. The bag should be transported and autoclaved in a leakproof tray or pan.

Surface Decontamination

- All containers and equipment should be surface decontaminated and removed from the cabinet when work is completed. At the end of the work day, the final surface decontamination of the cabinet should include a wipe-down of the work surface, the cabinet's sides and back, and the interior of the glass. If necessary, the cabinet should also be monitored for radioactivity and decontaminated when necessary. Investigators should remove their gloves and gowns and wash their hands as the final step in safe microbiological practices.
- Small spills within the BSC can be handled immediately by removing the contaminated absorbent paper toweling and placing it into the biohazard bag. Any splatter onto items within the cabinet, as well as the cabinet interior, should be immediately wiped with a towel dampened with decontaminating solution. Gloves should be changed after the work surface is decontaminated and before placing clean absorbent toweling in the cabinet. Hands should be washed whenever gloves are changed or removed.
- Spills large enough to result in liquids flowing through the front or rear grilles require more extensive decontamination. All items within the cabinet should be surface decontaminated and removed. After ensuring that the drain valve is closed, decontaminating solution can be poured onto the work surface and through the grille(s) into the drain pan.
- Twenty to thirty minutes is generally considered an appropriate contact time for decontamination, but this varies with the disinfectant and the microbiological agent. Manufacturer's directions should be followed. The spilled fluid and disinfectant solution on the work surface should be absorbed with paper towels and discarded into a biohazard bag. The drain pan should be emptied into a collection vessel containing disinfectant. A flexible tube should be attached to the drain valve and be of sufficient length to allow the open end to be submerged in the disinfectant within the collection vessel. This procedure serves to minimize aerosol generation. The drain pan should be flushed with water and the drain tube removed.
- Should the spilled liquid contain radioactive material, a similar procedure can be followed. Radiation safety personnel should be contacted for specific instructions.

Gas Decontamination

- BSCs that have been used for work involving infectious materials must be decontaminated before HEPA filters are changed or internal repair work is done (4,9-12). Before a BSC is relocated, a risk assessment which considers the agents manipulated within the BSC must be done to determine the need for decontamination. The most common decontamination method uses formaldehyde gas, although more recently hydrogen peroxide vapor (10) has been used successfully. This environmentally benign vapor is useful in decontaminating HEPA filters, isolation chambers and centrifuge enclosures (11).

California State university, Bakersfield

Department of Biology

Science Building I Room 308

Safety in the Microbiology Laboratory

Microbiology

Microbiology laboratories are unique environments in that the personnel routinely work with infectious agents. The two major areas of safety concern are biohazards (infectious agents) and environmental hazards (such as fire, caustic chemicals, etc.)

Cultures of Infectious Agents

In these laboratory exercises, you will work with potential pathogenic fungi (see lab book safety section for detail). None of the organisms used are highly virulent. However, any organism that is ingested or injected into the body has the potential to be pathogenic. This is especially true in immunocompromised individuals including pregnancy. To prevent the spread of infection to yourself, coworkers, or family, the following rules must be adhered to:

- . To prevent contamination of the laboratory with spores or conidia of fungi that may become airborne, we will do most of the laboratory procedures in the biological safety hood. Yeast cultures can be handled in the same manner that bacterial cultures are handled.
- . NEVER sniff a fungal culture to determine whether it has an odor.
- . Periodically wipe down the other counters and around sinks with bleach also. This is your lab, so take responsibility for its cleanliness and neatness.
- . Wipe down your workspace with a bactericidal disinfectant or 10% bleach when you first enter the laboratory before you begin work and again after you complete the exercise before you leave the room. Clean the entire lab bench, removing all dust and thus any dust borne microorganisms. Do the same for the biological safety hood
- . Turn on UV light inside the biological safety hood when done using it. Leave on.

- . A laboratory smock or coat must be worn while in the laboratory. It must remain in the laboratory and not be worn outside the laboratory. Remove the laboratory coat when you leave the laboratory. When removing the lab coat, turn it inside out, fold it over, and store it in the bottom drawer of your workstation. You may also put the coat in the closet provided. At the end of the term, bring a plastic bag to the last laboratory period, place your coat in it before removing it from your work area, and transfer it directly to a washing machine. Washing the laboratory coat in detergent will adequately kill the microbial contaminants.
- . Infectious waste (discarded Petri dishes, media, etc.) will be autoclaved. Place in the appropriate place as directed by the instructor. Nonglass items, such as the petri dishes, can go in the large plastic bags. All contaminated culture tubes that are to be reused go in the plastic tubs, which are then autoclaved. Please remove any tape before placing in the tubs. Do not put these reusable glass items in the sharps containers. Please place all old cultures in these receptacles as soon as you have completed the work. Do not let old cultures stack up in the incubators or refrigerators.
- . Sharps go in the sharps container (hard sided containers). This includes all disposable contaminated glass items such as test tubes and glass slides. When syringes and needles are used, do not recap the needles.
- . Small glass tubes, slides, and other small, contaminated items may also be placed in the workstation red-bagged containers.
- . Please do not put noninfectious waste such as paper towels that you have used to dry your hands and other papers into the infectious waste containers. The disposal of infectious waste requires special handling such as autoclaving.
- . Although some papers and pencils are necessary to record laboratory observations, keep the workstation as free of personal items as possible. Do not lay a petri dish or test tube on your notebook and risk contaminating your notebook. There are racks along the wall for your books. Hang up coats and sweaters. Your valuable items could be put close to you in one of the drawers on the workstation or in the bottom drawer. You may bring a lock to place on the drawer. Replace any reagents or equipment used during the lab to the proper place. It is important to avoid clutter and possible laboratory accidents.
- . If you're accidentally stab or contaminate yourself, flood the area immediately with alcohol, allow the alcohol to evaporate, and wash the area with a ski antiseptic. Antiseptic soap and first aid kit is in middle room over sink. Do not get alcohol in your eyes. Report all laboratory accidents to the instructor immediately.

- Micro steps of the manual method to be automated or semi automated

 1. sample (like pus/ urine) inoculated (seeded) in primary plates and if it contain any bacteria we get growth of that bacteria after 18-24 hrs of incubation at 37degree in forms of visible colony that measures usually 1mm to 3mm in diameter look like a thick dot. (these colonies are nothing but a bunch of multiplied bacteria which was just a single bacterium yesterday now multiplied in millions of bacteria and become visible collectively in colony form)
 2. now once bacteria isolated our work starts. Here we need automation . Now in conventional method we need to make a water suspension of a colony, and concentration of bacteria should be around 1000000 bacteria per ml .this suspension technically called bacterial broth (broth means liquid media) and this no of bacteria calculated or adjusted according to standard turbidity (turbidity means haziness) . Degree of haziness is proportional to no of bacteria present in that liquid suspension or broth. And it in real work adjusted according to barium chloride standard solution so if it matches with bacterial broth it means bacteria are 1000000/ml and ideal concentration for processing. Now this broth is ready for sensitivity plating (plating means painting of this broth on sterile culture plate usually of 9cm diameter and contain media to support growth of bacteria. In the same plate we also inoculate standard organism in outer circle after keeping gape of 3 mm (usually standard organism are those bacteria which is susceptible to all antibiotics to be applied and should be similar/ nearest to test bacteria.) This method is known as stocks method and considered a gold standard method in the field of sensitivity. This 3mm gape area is being chosen for keeping all antibiotic disc what we want to apply.
- antibiotic disc what we want to now u must know about the specification of this antibiotic disc. it is nothing but a filter paper disc of 6 mm soaked in antibiotic solution of a particular concentration and in 9 cm plate usually 6 such kind of discs are applied simultaneously, contains different antibiotics.

antibiotic disc what we want to now u must know about the specification of this antibiotic disc. it is nothing but a filter paper disc of 6 mm soaked in antibiotic solution of a particular concentration and in 9 cm plate usually 6 such kind of discs are applied simultaneously, contains different antibiotics. Advantage of this method is that we inoculate standard bacteria on same plate and we know it is sensitive to all antibiotics. So after keeping the disc we incubate this plate at 37 degree centigrade for 18-24 hrs. So if some thing goes wrong with plating media like pH, incubation temperature deviation of some suppressive element present in the media etc it affect growth of both test bacteria as well as control bacteria . so this helps in validation of report . actually we interpret result of sensitivity in compare to control organism. (note if bacteria is sensitive to a particular drug than it will not grow around that disc. so this area is measured as diameter of clear zone in millimeter and drug is considered sensitive if the test organism have zone size to a particular drug minimum up to three mm less of that standard organism .(example if zone size comes of test 15 mm and standard organism shows zone size 18 mm to a particular drug .

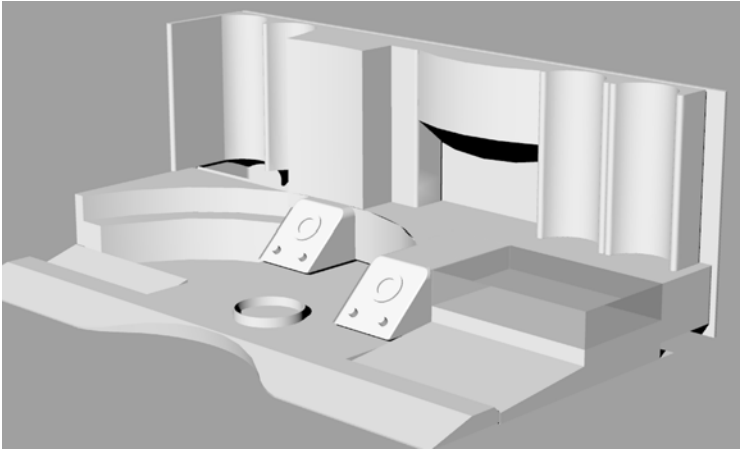
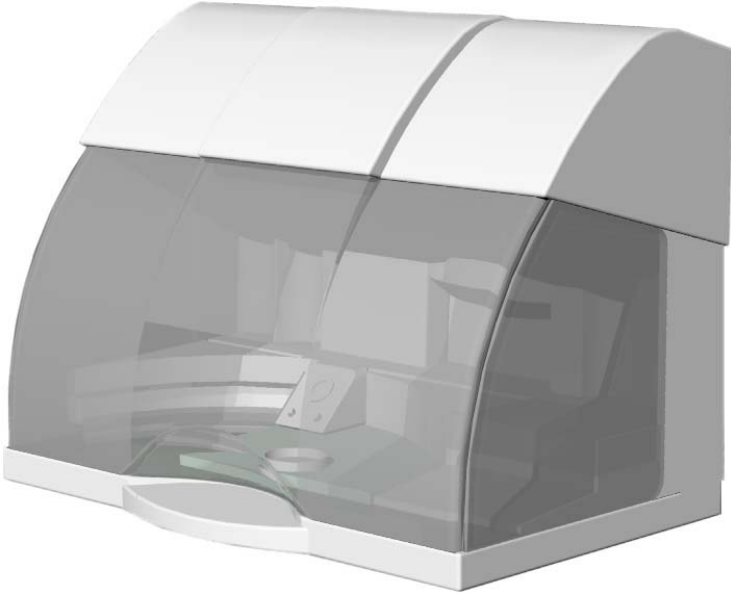
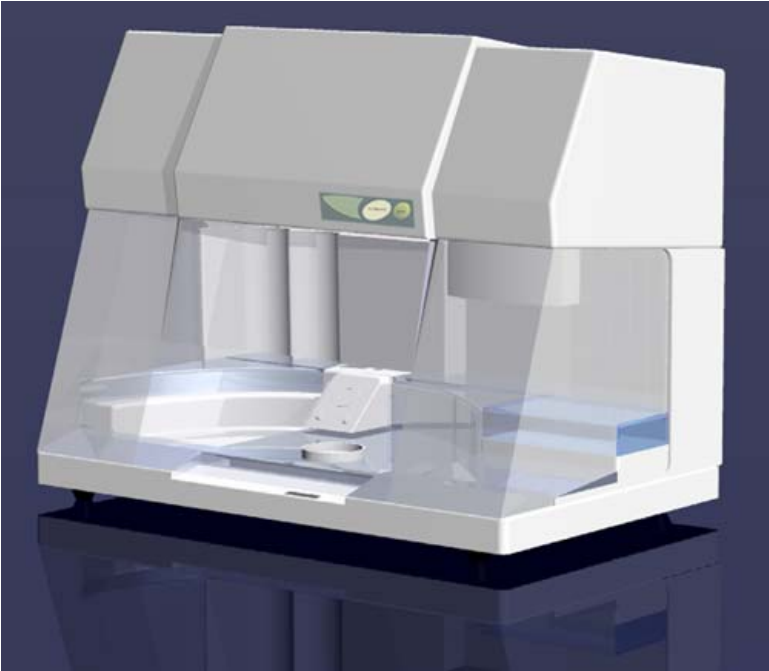
- the test organism will be still considered sensitive even it is less than 3 mm of standard organism but will be considered resistant to drug if zone size goes further bellow like 14 or less as in this example .) since both organism are in the same plate it has better validity value . In routine no buddy adopts this because it is difficult to inoculate in day to day practice in another words its not users friendly.
- usually 9 cm diameter round disc are being used which contain 4mm thick layer of media . but I think that plat can be of any shape and size only thing is that it should contain 4mm thick media . so in our planning we can make plat which make our working and automation easier .
- apart from this we can make certain accessories
 - desitometer
 - plate reader

as we have discuss that for a concentration of bacteria of 1000000/ml we need it to compare with barium chloride solution but this have problem that it has limited shelf life and visual comparison is not that accurate. So we can make such dedicated densitometry which can read our bacterial broth tube optically as optical density and we will standardize that a particular optical density will correspond to this .but such instrument is available with the name of densimat a product of bio-mereux a French company.
- plate reader can be an automated computerized instrument which will note zone size of different antibiotics. Principal is that reflection of zone will be different in bacterial growth zone and in the zone where bacteria is not grown . this instrument not only measure zone but automatically compare it with standard organism zone size and will interpret automatically and give final out come as this organism is sensitive to following organism and resistant to following organism . to this will reduce the need of skilled man power.

work station for medical diagnostic lab



work station for medical diagnostic lab



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