Department of Management Studies
INDIAN INSTITUTE OF SCIENCE

MG 286 PROJECT MANAGEMENT

End Semester Examination

02 May 2018 3 hours
Open Book ***Max. Marks: 100***

Note:

1. ***This is an <u>Open Book</u> Examination***
2. ***You may consult any source of information, records. notes, books, etc., including the Internet. The only exception: your neighbor***
3. Make suitable assumptions, where necessary, and state them in your answer.

1. An Interior Designer approaches you, seeking systems design consultancy to computerize her operations, comprising the following:
   - ***a.*** Conducting feasibility studies;
   - ***b.*** Preparing tender documents;
   - ***c.*** Tender advising;
   - ***d.*** Supervising site operations; and
   - ***e.*** Inspection and certification of the completed work.

On an average, the Interior Designer handles about 40 to 50 Customer Projects each year, with a total turnover of Rs. 50 million. Typically, each Project would involve at least 150 man days of work, in the above- mentioned operations. The extent of Reports to be generated would typically comprise 100 – 150 pages for each Project; in addition, an Information Database is to be created, with some 150 records of entry, each having about 10 to 12 fields.

1. Conduct a detailed systems design for the above interior designer; including the following activities:

1. Needs Analysis; (10 marks)
2. System Identification; ; (10 marks)
3. Synthesis of Solutions; (10 marks)
4. Feasibility Study. (10 marks)

Identify at least one "feasible" solution, comprising appropriate hardware/ software/ processes. (10 marks)

2. Prepare a Work Definition and Work Breakdown Structure for the above Interior Designer's Computerization Project (15 marks)

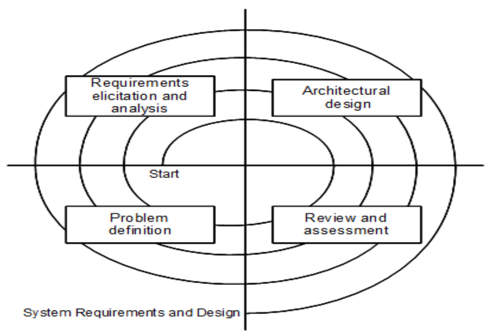
3. Conduct a PERT analysis, based on the Activity On Arc (AOA) network diagram, for the Interior Designer's Computerization Project, by including the following:
   - **a.** Calculation of the earliest expected and the latest allowable times for all the events;
   - **b.** Identification of the critical and near-critical paths; and
   - **c.** Explanation of the physical significance of the activities on the critical path(s).

(35 marks)

SYSTEM DESIGN

1.**Need Analysis**

- Primary objective of the need analysis phase of the system life cycle is to show clearly and convincingly the valid operational need
- Need analysis is a feasible approach to fulfill the need at an affordable cost and within an acceptable level of risk
- Whole process must produce persuasive and defensible arguments that support the stated needs and create a "vision of success" in minds of authorities for the start of new system development



Here the requirements to computerize interior designing operations are :

(1) Design CAD engineering
(2) Using the Grid System for Interior Designer's
(3) Smart Homes
(4) 3D Printing
(5) Virtual reality

Interior Design Laptop Computer & Software Requirements
Hardware Specifications

HARDWARE	**IDEAL PC**
Processor	Intel® Core™ i7–3820QM Processor (2.7GHz, 8M cache)
Memory	16 GB
Graphics Card	NVIDIA Gforce Graphics card
Screen	15"–17" or bigger

HARDWARE	IDEAL PC
Internal HD	512 GB or more, 7200RPM recommended or SSD if affordable
DVD	No
Ethernet	Yes
USB	Yes
Mouse	3 Button

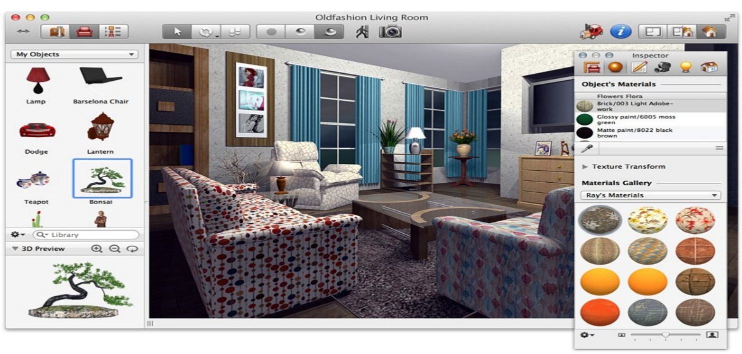
Additional Hardware Recommended for all Computers

- 32 GB or larger USB Thumb Drive
- 1 TB or larger External HD for backing up and archiving files
- Surge Protector
- Manufacturer's Extended Warranty
- Insurance (Work with your homeowner's or renter's insurance policy)

Design CAD engineering

Live Home 3D

Wonderful Interior Design App for professionals created by Belight Software, which is very easy to learn and can be a great alternative to expensive CAD software. After watching introductory tutorials available on the developer's website you will be able to make the full use of this app. While there are two versions available – basic and Pro, I strongly recommend you to go for a Pro version, to enjoy such extensive features, as the ability to design unlimited number of stories, niches and wall cutouts, export images in high resolution, add a light source to any object and advanced material editor.



Archicad

As the name suggests this software was created mainly for architects, thus mainly focuses on their needs. It is perfect for creating architectural plans, elevations and sections. This is one of the most popular CAD software that interior designers use. It is available both in Windows and Mac versions and you can download a free trial from the Autodesk website. Although Autocad gives a lot of opportunities to a user, it is not an easy program to learn. You don't need to be a techno guru, but you will need a lot of patience and determination, but as award you will be able to produce very realistic renderings

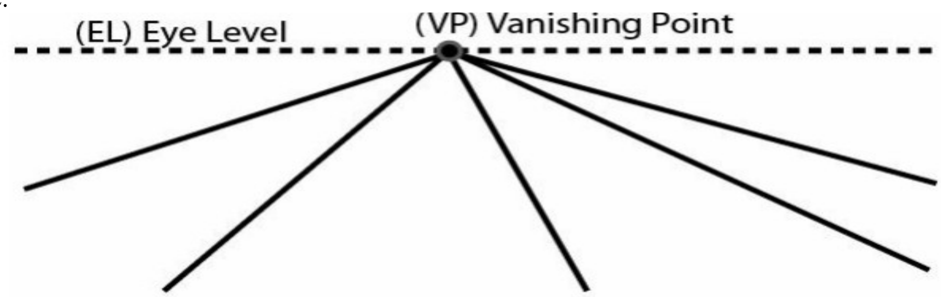
Using the Grid System for Interior Designer's

The grid system is a simple and efficient way of learning perspective quickly and accurately with a minimum of work and effort.
Perspective allows a designer to create the illusion of depth and dimension on a twodimensional surface. Without successful perspective, no rendering will look accurate. However, with a correct perspective drawing, an object can be rendered quickly.

Perspective in real life.

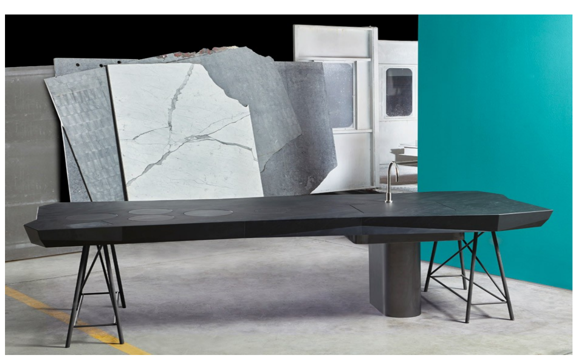
Here is a picture of the air force academy where each square on the ground is perfectly spaced from the other. But as we look off in the distance the lines that make up the boxes seem to narrow and come closer together. The point where the lines come together is known as the vanishing point. There is also a line that runs horizontally across the page and through the center of the vanishing point. This horizon line also marks the eye level of the observer.

By drawing lines on the pictures you can see the perspective lines converging to the vanishing point and eye line.



Smart Home

It's 2016 and smart homes are everywhere. Barely a day goes by without one of the tech giants releasing a new gadget designed to make our homes more connected. Google Home was unveiled – a smart home control center that acts as a personal assistant, alarm and speaker rolled into one. Speak to your Google Home device and it will turn up your heating, turn off your television, or remind you about upcoming appointments.

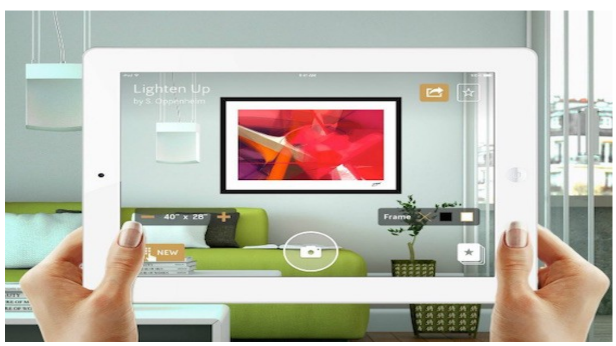


3D Printing

The advancement in 3D printing is shaping the interior world to such an extent that some believe we are on the cusp of another industrial revolution. Where it used to be costly and cumbersome, today 3D printing is efficient and exciting. Interior designers can quickly demonstrate their designs and allow their clients to touch and feel their ideas in miniature form. With 3D printing, the time between idea conception and its implementation is drastically reduced. This speeds up an interior designer's work and reduces costs for the client – a win for both parties.

Virtual Reality

Virtual reality (VR) has been the word on everyone's lips this year. From glorifying gaming to helping with healthcare, VR is set to take center stage in many an industry over the next few years. Interior experts are particularly excited about its uses within their profession. Imagine a designer walking their client through a room they have created, or explaining an architectural structure by actually being beside it. Imagine testing out hundreds of wallpaper designs, furniture pieces or flooring types at the click of a button. It's no surprise that the interior design industry is welcoming VR as the start of a new, technological future.



2.System Identification

System Identification the desired and undesired outputs, the controllable, uncontrollable and environmental inputs, and the design parameters, along with the constraints for each of the parameters. The primary outputs from the interior design are conceptual development, space planning, site inspections, programming, research, communicating with the stakeholders of a project, construction management ; the main inputs are execution of the design , capital, and technology; and the important design parameters are capacity, size, and number of operating days (and the associated operating cost).

Criteria for Evaluation
The alternate systems for interior design will be evaluated on the basis of the maximum net return (net profit) to the owner (interior designer).

Interior design identification :

S.No.	Parameter	Item description	Constraint
1	Desired outputs	Execution of the design	Within Client Quote
2	Undesired outputs	Wastage of material	Shouldn't be more than 5% of investing/raw material.
3	Controllable input	1.Computers 2.CAD Softwares 3.VR sets 4.3D Printers 5.Smart Home components 6.Server	25 All latest licensed 15 1 If client requires 1 (If data increases/backup)
4	Uncontrollable inputs	1. Solar energy 2. Temperature	About 0.5 kW/sqm between 18 degree C and 25 degree C
5	Design parameters	1. Size 2. Capacity 3. Operating days 4.Operating cost	Separate space for systems 25 computers and 1 server 150 man days of work Total turnover of Rs. 50 million
6	Criteria for evaluation	Net return/net profit to owner	Maximize

Subject to the above conditions, the net return to the owner (interior design) will be maximized.

3.Synthesis of Solutions

The major function to be performed to achieve the desired objective is designing.
The following systems have been identified to perform the major function:

Traditional designing (A)
- Site inspections ;
- Space planning;
- Conceptual development;
- Execution.

Digital designing (B)
- Blueprint
- Computer-aided design
- Virtual reality inspection
- Execution

4.Feasibility of Proposed Systems

Feasibility of a system concept cannot be established solely on the basis of its functional design. Issue of feasibility must also address the physical implementation

- Visualizing the physical nature of subsystems conceived to perform the needed system functions
- Defining a feasible concept in terms of capability and estimated cost by varying (trading off) the implementation approach as necessary

The following components of feasibility have been considered in this case study:
a. Physical realisability;
b. Financial feasibility;
c. Economic practicability.

Social and political realisability have not been explicitly taken into account, as these are difficult to quantify. However, the alternate design systems are socially and politically acceptable at present.

Detailed assessment of feasibility of interior design

			Performance/ requirement of system	
Parameter	**Item description**	**Constraint**	**A**	**B**
Physical feasibility	>Desired outputs /Design 1. Other foreign materials 2. Capacity 3. Land 4. Labour (unskilled) 5. Labour (skilled) 6. Power 7. Water	Within Client Quote 0.2 million Within office space 25 capacity support/cleaning Engineers/Dev 50-100 kW about 0.09 cusec	Will cost lesser than digital design. No accessories for computers No Extra room no technical support - 16 hours supply 0.09	Costs high it includes technology stuff. Extra accessories for computers Extra room(computers) 0.03 million cost for technical supp. 0.4 million 24*7(computers) 0.09
Financial feasibility	1. Capital cost 2. Salvage value	20 million about 10% of capital cost	6 million 10%	14 million 10%
Economic feasibility	1. Operating cost 2. Maintenance 3. Spares	0.04 million per day about 1% of capital cost about 2% of capital cost	0.01m 0.025% 0.5%	0.03m 0.075% 1.5%

Note :

1. The above values are based on estimated values as perfect data is unavailable. outlines the detailed assessment of the physical, financial, and economic feasibility of the interior design.

From the above detailed assessment of feasibility, it can be seen that:

> *The Traditional designing* (A) is physically feasible, while it may be financially and economically feasible; meets all the desired requirements of physical, financial, and economic feasibility; but it takes lot of time and lot of manpower required.

> *The Digital designing* (B) is is probably physically infeasible,while it may not be financially and economically feasible; but it takes less time to complete as it includes machine work and software work which delivers output in less time.

Work Definition

Interior design is a multi-faceted profession in which creative and technical solutions are applied within a structure to achieve a built interior environment. These solutions are functional, enhance the quality of life and culture of the occupants, and are aesthetically attractive. Designs are created in response to and coordinated with the building shell, and acknowledge the physical location and social context of the project. Designs must adhere to code and regulatory requirements, and encourage the principles of environmental sustainability. The interior design process follows a systematic and coordinated methodology, including research, analysis and integration of knowledge into the creative process, whereby the needs and resources of the client are satisfied to produce an interior space that fulfills the project goals.

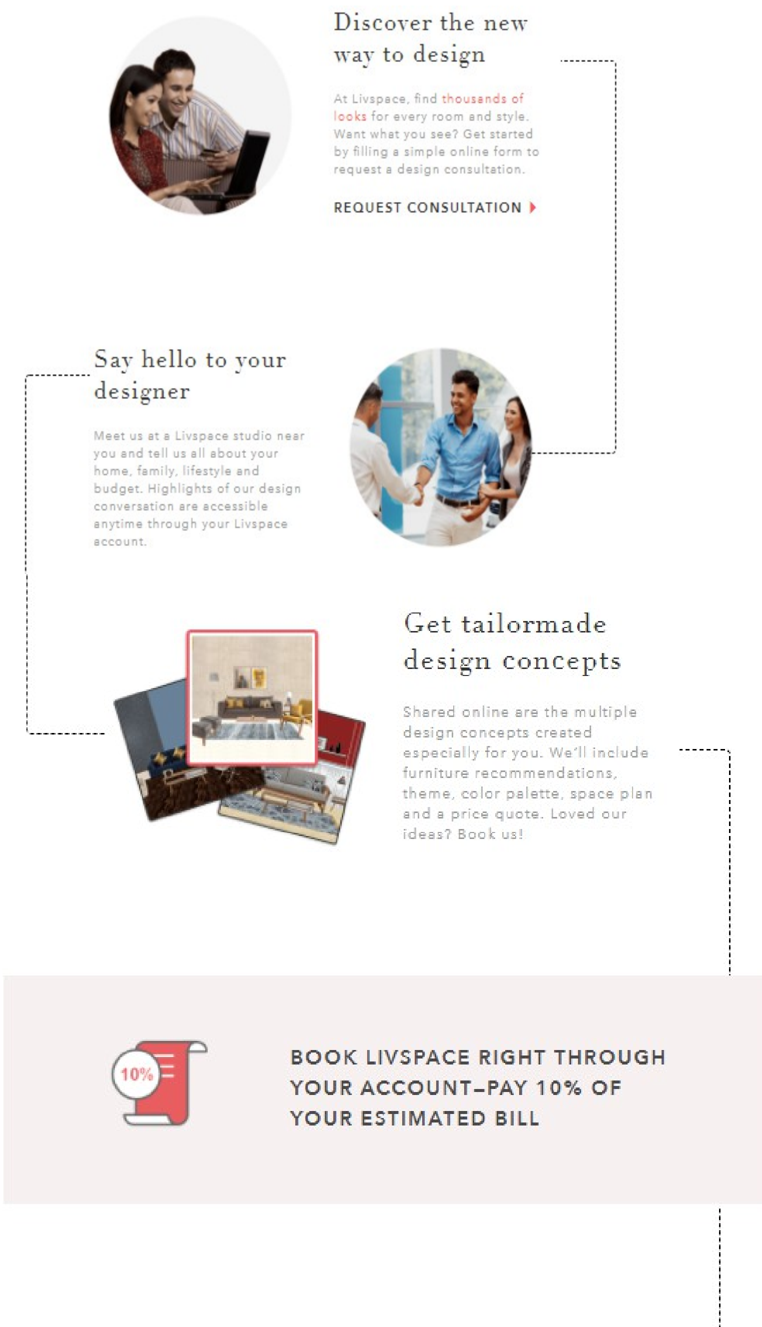
Interior design includes a scope of services performed by a professional design practitioner, qualified by means of education, experience, and examination, to protect and enhance the life, health, safety and welfare of the public. These services may include any or all of the following tasks:

- Research and analysis of the client's goals and requirements; and development of documents, drawings and diagrams that outline those needs;
- Formulation of preliminary space plans and two and three dimensional design concept studies and sketches that integrate the client's program needs and are based on knowledge of the principles of interior design and theories of human behavior;
- Confirmation that preliminary space plans and design concepts are safe, functional, aesthetically appropriate,and meet all public health, safety and welfare requirements, including code, accessibility, environmental, and sustainability guidelines;
- Selection of colors, materials and finishes to appropriately convey the design concept, and to meet psychological, functional, maintenance, life-cycle performance, environmental, and safety requirements;
- Selection and specification of furniture, fixtures, equipment and millwork, including layout drawings and detailed product description; and provision of contract documentation to facilitate pricing, procurement and installation of furniture;
- Provision of project management services, including preparation of project budgets and schedules;
- Preparation of construction documents, consisting of plans, elevations, details and specifications, to illustrate non-structural and/or non-seismic partition layouts; power and communications locations; reflected ceiling plans and lighting designs; materials and finishes; and furniture layouts;
- Preparation of construction documents to adhere to regional building and fire codes, municipal codes, and any other jurisdictional statutes, regulations and guidelines applicable to the interior space;
- Coordination and collaboration with other allied design professionals who may be retained to provide consulting services, including but not limited to architects; structural, mechanical and electrical engineers, and various specialty consultants;
- Confirmation that construction documents for non-structural and/or non-seismic construction are signed and

sealed by the responsible interior designer, as applicable to jurisdictional requirements for filing with code enforcement officials;

HOW IT WORKS

Home interiors designed from start to finish



Collaborate and get final designs

Get detailed designs for every room. You can request changes, select colors, upholstery, wallpaper, finishes and more till you're 100% satisfied.

CONFIRM ORDER AND PAY 40% OF YOUR FINAL BILL

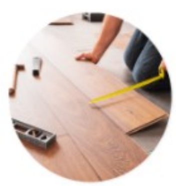
Your interiors, created with precision and care

We now get it rolling and manufacture and curate all your chosen furniture, decor, modular components and more. The best of quality is ensured with checks at every step.

MAKE BALANCE PAYMENT AND GET DELIVERY

Relax as we manage complete installation

Our team plans, supervises and executes everything from civil work to wall treatments and sends you regular status updates online. When done, you get a perfect home, expertly installed and finished.



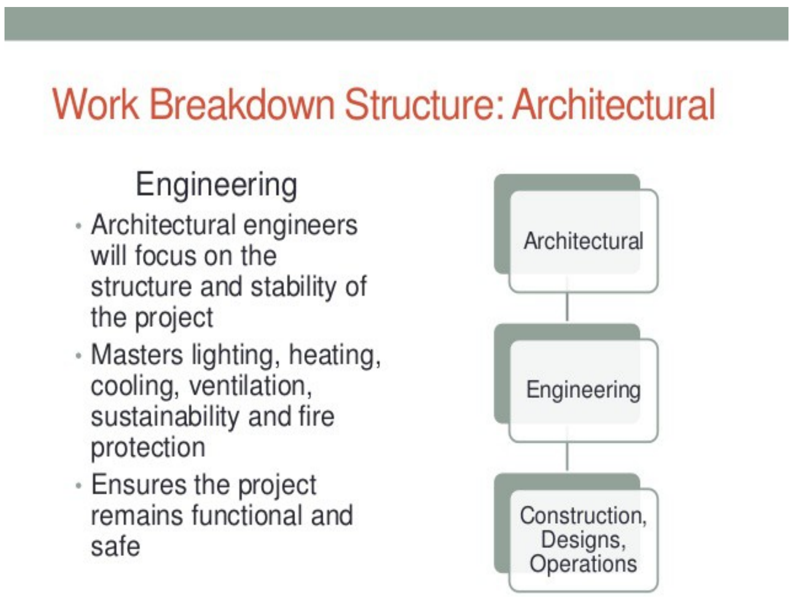
Enjoy your new Livspace home

Get featured in the Livspace magazine and show off your beautiful new home to the whole world. Lights, camera, professional styling, an interview and a stylish family portrait – it's all on us!

Work Breakdown Structure

The WBS is the single-most important element in project implementation because it provides a common framework from which:

- The total project can be described as a summation of sub-projects, tasks, and work packages; Planning can be performed;
- Costs and budgets can be established; Time, cost, and performance parameters can be tracked to monitor the project;
- Project objectives can be linked to the organization's resources in a logical manner; Schedules and status-reporting procedures can be established;
- Network construction and control planning can be initiated; and The responsibility assignments for each element can be established



A typical hierarchy in the Work Breakdown Structure (WBS) of a project :

Level	Element description
1	Project
2	Sub-project
3	Task
4	Sub-task
5	Work package

step one - client consultation

During the programming phase the client's needs and objectives are identified. Questions regarding the specific function(s) of the space, who will be using the space and furniture and equipment requirements will be discussed. Measurements and photos are also taken at this time.

step two - schematic design

In the schematic design phase, space planning and furniture layouts are developed. Circulation patterns and minimum clearances are considered and applied to the floor plan. Rough sketches and elevations are created, preliminary furniture and finish ideas are developed and then presented to the client for review and revision.

step three - design development

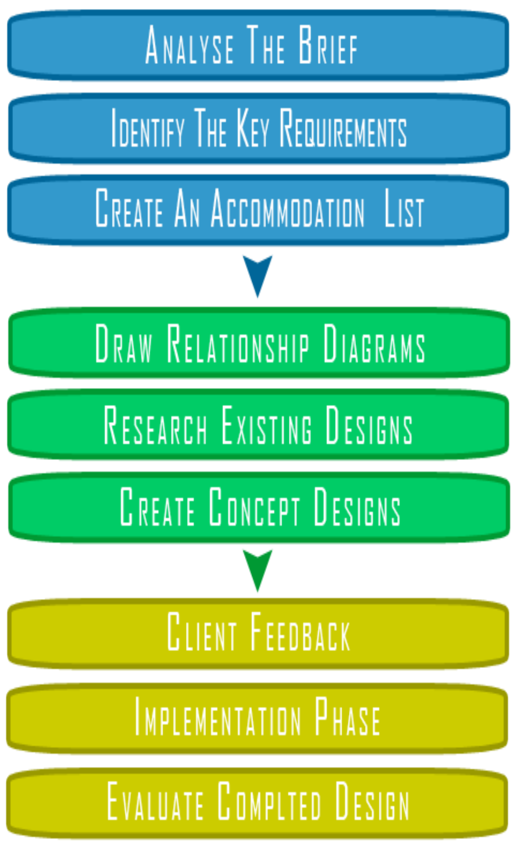
After final approval of the schematic design, the designer develops floor plans, elevations and other related items in greater detail. Colors and finishes are refined, furniture, fabrics and equipment are selected and cost estimates are prepared. The resulting design is presented to the client for review, revision and final approval.

step four - construction documentation

In the first phase, the specific details of the work to be completed are documented. These details include millwork specification, finish selections such as flooring and paint, lighting plans and fixture selection, plumbing location and fixture selection, and electrical layouts in regard to the total scope of work to be completed. In the second phase, bids are obtained, contractors selected, and purchase orders are issued.

step five - construction administration

This is the final stage where things are built and installed. The designer is often onsite during "installation" to ensure items are received in good condition, installed correctly, and that documents have been followed properly.



PROGRAMMING

UNDERSTANDING YOUR GOALS.

Our team will conduct visioning sessions where we investigate and explore your goals, listen to your ideas, and most importantly, learn about your company culture.

Some of the information discussed and collected during the Programming stage includes:

- What are your goals for this project?
- What is your brand? Who is your target market?
- What do you like and what works about your existing space? What needs improvement?
- What is your budget?

SCHEMATIC DESIGN

CREATING A SPACE WITH PURPOSE.

We will develop a layout for your new space so that it is functional, safe, and accessible by examining the needs of your end users, as well as local building codes, traffic flow, and requested adjacencies or relationships.

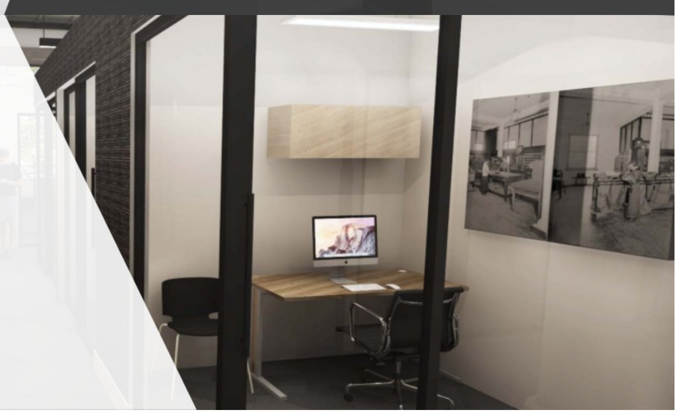
In the Schematic Design stage you may receive:

- a site measure of your existing or new space and inventory of existing fixtures, furniture or equipment to be reused;
- creation of a CAD drawing based on existing site conditions;
- review of building code & local regulations as it pertains to your project;
- space plans; and
- a meeting or two to review and make changes to the layout.

DESIGN DEVELOPMENT

TRANSFORMING YOUR VISION INTO A UNIQUE DESIGN PLAN.

Shouldn't the design of your space be as unique as your business? We think so. Our design team is purposeful and mindful when expressing your brand image through the interior design. During this phase, your project will come to life in 3D – a perk you enjoy by working with us.



FURNITURE

WORKING WITH MANUFACTURERS AND DISTRIBUTORS TO FIND THE BEST SOLUTIONS FOR YOUR PROJECT.

We work closely with our manufacturing and distributing contacts to select appropriate furniture that meets your budget, timeline, and functional requirements, while obtaining quotes to initiate orders.

In the Furniture stage you may receive:

- internal research of available furniture options;
- internal review of available options;
- basic 3D images of the design concept;
- selection of finishes for chosen furniture;
- one or two meetings to review and make changes to the proposed options; and
- quotes to initiate orders for furniture.

CONTRACT DOCUMENTS

USING OUR EXPERIENCE TO FORMULATE A PACKAGE FOR PRICING AND CONSTRUCTION.

Contract documents typically consist of drawings and specifications; they provide the technical details to build your design plan. To help provide you with a complete design package, we coordinate with various project consultants including Structural, Mechanical, and Electrical Engineers as well as building Architects.

In the Contract Document stage you may receive:

- a complete set of interior design construction drawings (ready for permits, pricing, and construction): floor plans, ceiling plans/basic lighting plans, basic electrical plans, elevations, details/sections, and finish specifications;
- coordination with other project consultants including weekly check-ins;
- a review meeting with you for final sign-off on plans; and
- preparation of all materials required so you can apply for a building permit.

TENDER AND PROJECT ADMINISTRATION

ENSURING THE QUALITY OF THE BUILT SPACE MATCHES THAT OF THE DESIGNED SPACE.

We have established relationships with a variety of General Contractors who can participate in the project tender. We are able to recognize General Contractors who will best fit your project goals allowing you to obtain the best combination of pricing, quality, and scheduling.
You have invested time and money into a thoughtful design plan, now we will act as the mediator between you and the General Contractor while entertaining solutions when changes are required.

In the Tender and Project Administration stage you may receive:

- pre-qualification of 3 General Contractors to participate in project tender;
- communication with bidders during tender;
- issue clarifications and addenda during tender;
- coordination of contract between you and your selected General Contractor;
- construction kick-off meeting;
- communication with you and the General Contractor over the course of construction;
- review of shop drawings and submittals;
- site visits to review any deficiencies and inspect completed work;
- documentation as needed to monitor changes and provide direction to the General Contractor; and
- review progress invoices submitted by the General Contractor and provide

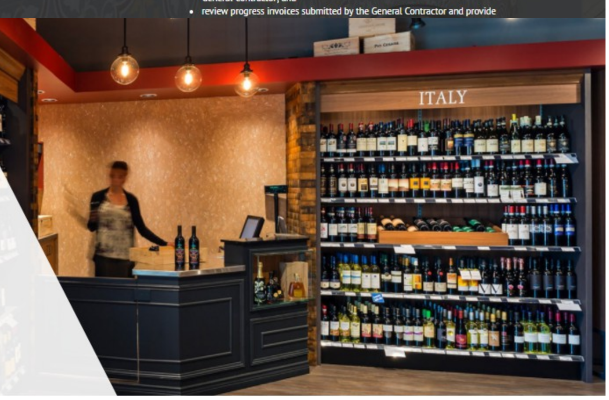
OTHER OPTIONAL SERVICES

CUSTOMIZE YOUR PACKAGE.

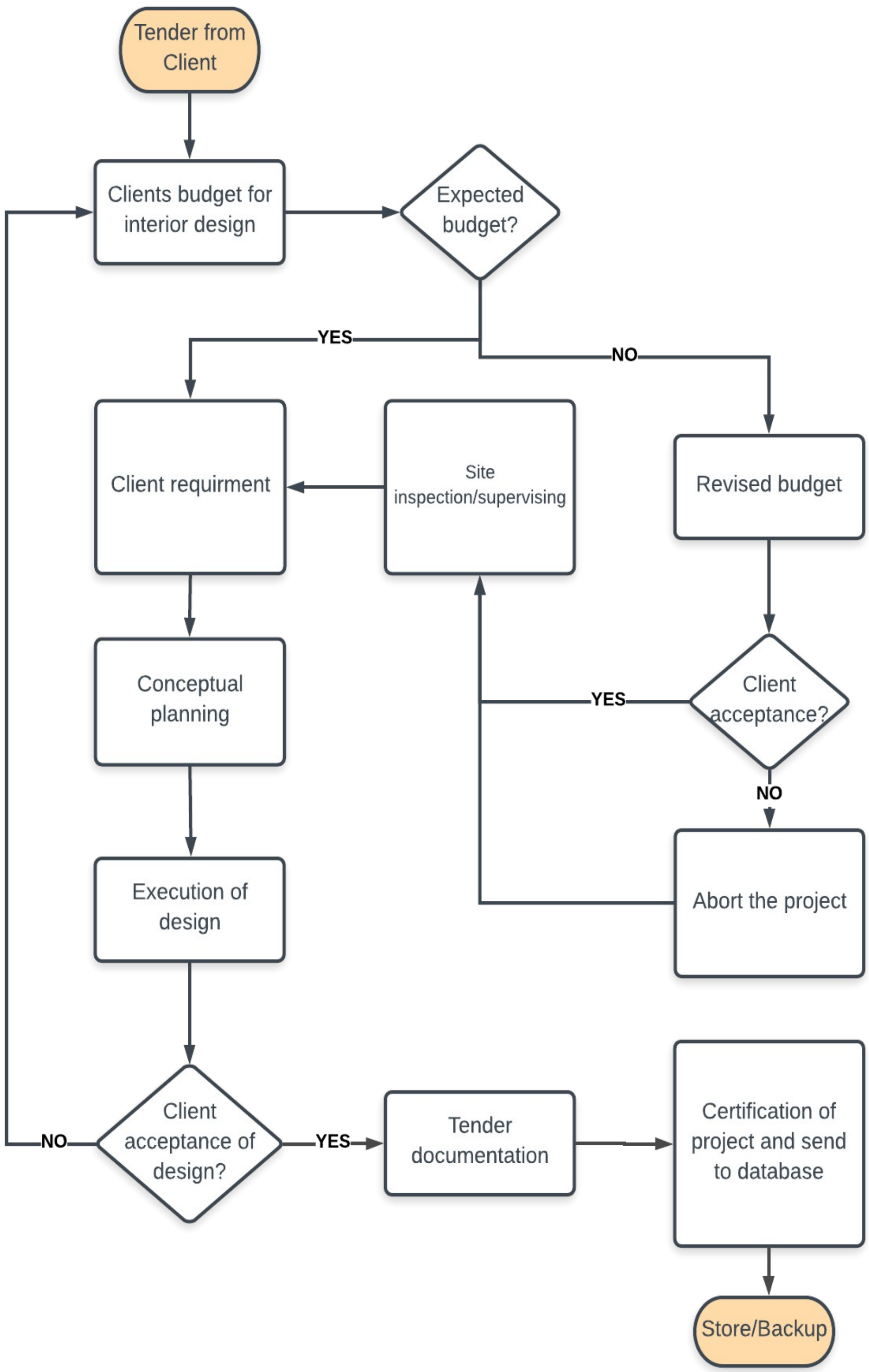
Every project is different, so we offer a variety of optional services tailored to your needs.

Optional services you may need include:

- As-built drawings that reflect the finished project including any changes. This is ideal to have on hand for future projects.
- Photo-realistic renderings ensure you have the visual wow-factor you need to present your project and gain the support of investors and stakeholders.
- An inventory of existing furniture and equipment allows you to do what you do best by engaging our designers to complete the list on your behalf.
- Project styling adds that finishing touch to a well-designed space with artwork and accessories.

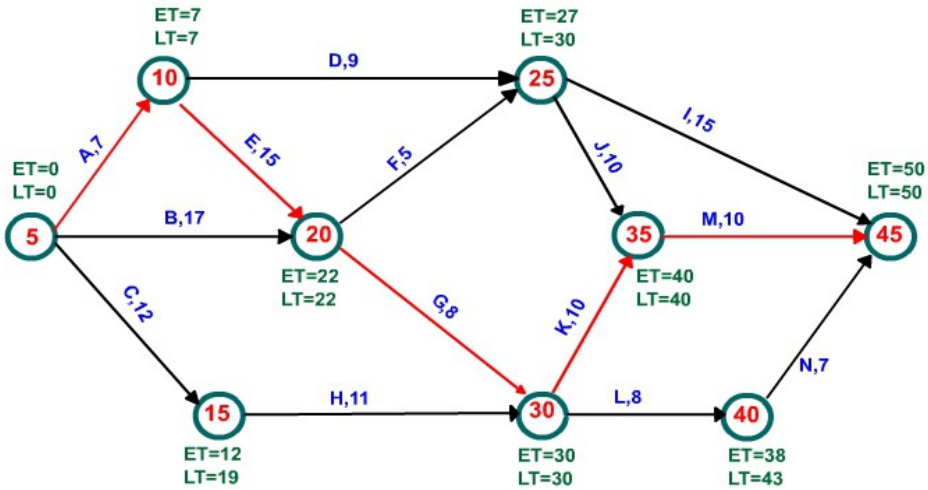


Programme Evaluation and Review Technique (PERT)



generated from lucidchart.com

In the project network given in figure below, activities and their duration's are taken at random :.



Calculations in Network Analysis
The following calculations are required in network analysis in order to prepare a schedule of the project.

a.Total completion time of the project
b.Earliest time when each activity can start (i.e. earlist start time)
c.Earliest time when each activity can finish (i.e. earlist finished time)
d.Latest time when each activity can be started without delaying the project (i.e. latest start time)
e.Latest time when each activity can be finished without delaying the project (i.e. latest finish time)
f.Float on each activity (i.e. time by which the completion of an activity can be delayed without delaying the project)
g.Critical activity and critical path

The symbols used in the calculations are shown in table below.

Symbol	Description
E_i	Earliest occurance time of event i
L_j	Latest allowable occurance time of event j
t_E^{i-j}	Estimated completion time of activity (i,j)
$(EST)_{ij}$	Earliest starting time of activity (i,j)
$(EFT)_{ij}$	Earliest finishing time of activity (i,j)
$(LST)_{ij}$	Latest starting time of activity (i,j)

$(LFT)_{ij}$	Latest finishing time of activity (i,j)

The computations are made in following steps.

(a) Forward Pass Computations :

$$(EST)_{ij} = E_i$$

$$(EFT)_{ij} = \text{Maximum of } \left[(EST)_{ij} + t_E^{ij}\right] \forall\, i-j \text{ leading into event } j$$

(b) Backward Pass Computations :

$$(LFT)_{ij} = L_j$$

$$(LST)_{ij} = \text{Minimum of } \left[(LFT)_{ij} - t_E^{ij}\right] \forall\, i-j \text{ emanating from node } i$$

(c) Calculation of Slack:

Event slack is defined as the difference between the latest event and earlist event times.

Slack for head event = $L_j - E_j$

Slack for tail event = $L_i - E_i$

The calculations for the above taken example network are summarised below in the table.

Predecessor Event i	Successor Event j	t_E^{i-j}	$(EST)_{ij}$	$(EFT)_{ij}$	$(LST)_{ij}$	$(LFT)_{ij}$	S(i) Slack
5	10	7	0	7	0	7	0
5	15	12	0	12	7	19	-
5	20	17	0	17	5	22	-
10	20	15	7	22	7	22	0
10	25	9	7	16	21	30	-
15	30	11	12	23	19	30	7
20	25	5	22	27	25	30	-
20	30	8	22	30	22	30	0
25	35	10	27	37	30	40	3
25	45	15	27	42	35	50	-
30	35	10	30	40	30	40	0
30	40	8	30	38	35	43	-

35	45	10	40	50	40	50	0
40	45	7	38	45	43	50	5

(d) Determination of Critical Path:

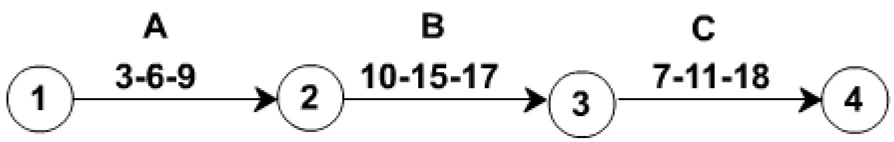
The sequence of critical activities in a network is called the critical path. The activities with zero slack of head event and zero slack for tail event, are called as critical activities.

In the taken network, the following activities are critical activities: 5 - 10, 10 - 20, 20 - 30, 30 - 35, 35 - 45. Thus the critical path is A-E-G-K-M.

Critical path duration is 7 + 15 + 8 + 10 + 10 = 50.

Calculation of Expected Time and Variance of a Path in PERT

The Expected Time of a chain of activities in series, is the sum of their expected times. Similarly the variance of the path, is the sum of variances of activities on the path. In Figure below, three activities A,B and C are connected in series, (i.e. form a path). Their time estimates t_o-t_m-t_p are given along the activity arrows. The expected time of the path 1-2-3-4 is calculated as:



$$
\begin{aligned}
t_E^{1\text{-}2\text{-}3\text{-}4} &= t_E^{1\text{-}2} + t_E^{2\text{-}3} + t_E^{3\text{-}4} \\
&= \frac{3+4*6+9}{6} + \frac{10+4*15+17}{6} + \frac{7+4*11+18}{6} \\
&= 6 + 14.5 + 11.5 \\
&= 32
\end{aligned}
$$

t_E could also be computed as

$$
\begin{aligned}
t_E^{1\text{-}2\text{-}3\text{-}4} &= \frac{\sum t_o + 4\sum t_m + \sum t_p}{6} \\
&= \frac{(3+10+7) + 4(6+15+11) + (9+17+18)}{6} \\
&= 32
\end{aligned}
$$

The Variance for the path is given by

$$
\begin{aligned}
v^{1\text{-}2\text{-}3\text{-}4} &= \left(\frac{9-3}{6}\right)^2 + \left(\frac{17-10}{6}\right)^2 + \left(\frac{18-7}{6}\right)^2 \\
&= 1 + (1.17)^2 + (1.83)^2 \\
&= 5.72
\end{aligned}
$$

As the length of the path ,that is the number of activies connected in series increases,the variance of the path and hence the uncertainty of meeting the expected time also increases

Considerations in Identifying Near-Critical Path

The concept of near-criticality is based on the CPM calculations that evaluate how close any activity in a logic network is to becoming a critical-path activity. A continuous sequence of activities within a network is called a path. The longest continuous sequence of activities which establishes the minimum overall project duration (may be more than one path) is called a critical path. A lesser critical sequence of activities might then be considered a near-critical path.

The concept of near-criticality is applicable to both a project activity and a network path; this recommended practice primarily focuses on near-critical paths. Near-criticality can be defined in different ways. Similar to critical paths, near-critically is primarily based on closeness either to lowest float path or longest path. As such, near critical paths may be identified using any of the following methods :

Deterministic Methods

a) Near-critical float: If the float that is available to a near-critical path is consumed, the near-critical path also becomes critical in parallel with the existing critical path of the network, and if float consumption continues, the path that was near-critical becomes the new critical path from that point on wards. A near-critical path may or may not partially overlap with the existing critical path of a network. Some authors suggest establishing ranges just above the critical path float to identify near-critical activities. These ranges are subject to expert judgment and may vary from one project to another. Most project planning and schedule software applications allow users to filter project activities that have total float values within certain ranges (e.g., less than a value, less than or equal to a value, or equal to a value). Schedulers should refrain from accepting the default settings when evaluating the criticality level of activities in an effort to seek justifiability and suitability of values chosen. No single, specific float value exists that correctly identifies near-critical path activities in all situations. The amount of float that is available to a near-critical path is mainly driven by the time required to take necessary corrective actions. In some projects, one week might be more than enough time to take needed remedial actions. In this case, a network path with a total float value of less than a week but more than three days might be considered near-critical. In another project, a week might be inadequate to prevent near-critical

Suppose now that we have a target time (T) for completing the project. T may have been originally expressed as a calendar date, e.g., October 1 or February 15. When is the latest time that the project can be started and finished?
In order to be feasible it is clear that T must be greater (later) than or equal to F, the early finish time for the project. Assuming this is so, we can define the concept of late finish (LF), or the latest time that a job can be finished, without delaying the total project beyond its target time (T). Similarly, late start (LS) is defined to be LF—t, where t is the job time.

These numbers are determined for each job in a manner similar to the previous calculations except that we work from the end of the project to its beginning. We proceed as follows:

(1) Mark the value of T to the right and left of Finish.

(2) Consider any new unmarked job *all of whose successors have been marked,* and mark to the right of the new job the *smallest* LS time marked to the left of any of its immediate successors.

The logic of this is hard to explain in a few words, although apparent enough by inspection. It helps to remember that the smallest LS time of the successors of a given job, if translated into calendar times, would be the latest finish time of that job.

(3) Subtract from this number the job time and mark the result to the left of the job.

(4) Continue until Start has been reached, then stop.

At the conclusion of this calculation the LF time for a job will appear to the right of the circle which identifies it, and the LS time for the job will appear to the left of the circle. The number appearing to the right of Start is the latest time that the entire project can be started and still finish at the target time T.

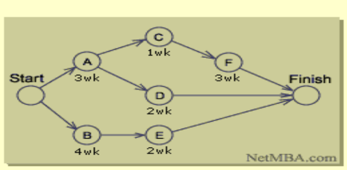
In Exhibit V we carry out these calculations for the example of Exhibit III. Here T = F = 100, and we separate early start and finish and late start and finish times by semicolons so that ES; LS appears to the left of the job and EF; LF to the right. Again the reader may wish to check these calculations for himself.

Exhibit V Calculation of Late Start and Late Finish Times for Each Job

c. The numbers inside the nodes have no significance, and are used only to identify the event. The numbers do not need to be in any sequence, but every event must have a unique number. An activity can be defined by the AOA method in two ways: either by its code.
It utilizes a chart that consists essentially of a series of circles, each of which represents a particular part of a project, and lines representing the activities that link these parts together. The critical path is the minimum time that a project can take, represented by the greatest of the times that are obtained by totaling the individual activities on any path from start to finish.

CPM models the activities and events of a project as a network. Activities are depicted as nodes on the network and events that signify the beginning or ending of activities are depicted as arcs or lines between the nodes. The following is an example of a CPM network diagram:

CPM Diagram



Steps in CPM Project Planning

1. Specify the individual activities.
2. Determine the sequence of those activities.
3. Draw a network diagram.
4. Estimate the completion time for each activity.
5. Identify the critical path (longest path through the network)
6. Update the CPM diagram as the project progresses.

While the need for project management and Critical path method are not new concepts, recent advances in both technology and project management methodologies have advanced the use of these portals. Many companies have seen the benefits of a Project scheduling with methods such as CPM, enabling them to optimize project delivery across their enterprises. This method has allowed them to effectively plan and manage critical task of projects with priority, delivering the right information to the right people at the right time for maximum collaboration and control. With such an immense and measurable impact on projects, CPM will undoubtedly continue to play a major role for organizations worldwide in the years to come, transforming business.

An activity is a physically identifiable part of a project, which consumes both time and resources. Activity is represented by an arrow in a network diagram The head of an arrow represents the start of activity and the tail of arrow represents its end. Activity description and its estimated completion time are written along the arrow. An activity in the network can be represented by a number of ways: (i) by numbers of its head and tail events (i.e. 10-20 etc.), and (ii) by a letter code (i.e. A, B etc.). All those activities, which must be completed before the start of activity under consideration, are called its predecessor activities. All those activities, which have to follow the activity under consideration, are called its successor activities . An activity, which is used to maintain the pre-defined precedence relationship only during the construction of the project network, is called a dummy activity. Dummy activity is represented by a dotted arrow and does not consume any time and resource . An unbroken chain of activities between any two events is called a path