Software Engineering
Prof. N.L. Sarda
Department of Computer Science & Engineering
Indian Institute of Technology, Bombay
Lecture # 23
Case Study: Part – I
Library Book Circulation System

In this module we will do a case study on the software methodology that we have studied in this course. The purpose of the case study is to illustrate the entire development life cycle. We will look at how the different physics we have identified can be applied systematically step by step in developing a software application. The purpose of this case study is to focus on the methodology, what are deliverables, what steps and techniques we go through. Idea is to understand the entire process of development as an engineering process and see that the various deliverables are produced, reviewed and then only we follow subsequent stages in the development. So this case study is a case study on library application. It's a application where the library is handle issue and receiving of books from the users of the library. So this is a real realistic application and the way it is being presented is the way it can be done and it should be done. Now the organization we are talking about here could be any library of any university.

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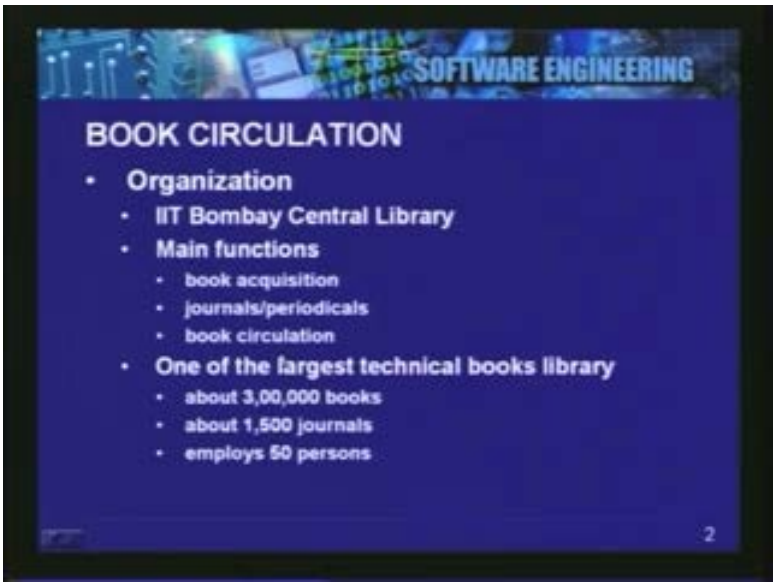

So let us assume that it is a library at the Indian institute of technology, Bombay whose main functions are buying books for its users also buying journals and periodicals. And then they have a function called books circulation function which issues books to the members of the library. It's one of the largest technical library having more than 3 lacks books and employees about 50 persons. So this is the organization which has this circulation function. Its users are the faculty and the staff as well as the students who are studying at this institute. In addition it has corporate members, these are the members

who are external organizations who would like to refer to the books in the library. So these are the main users of the library.

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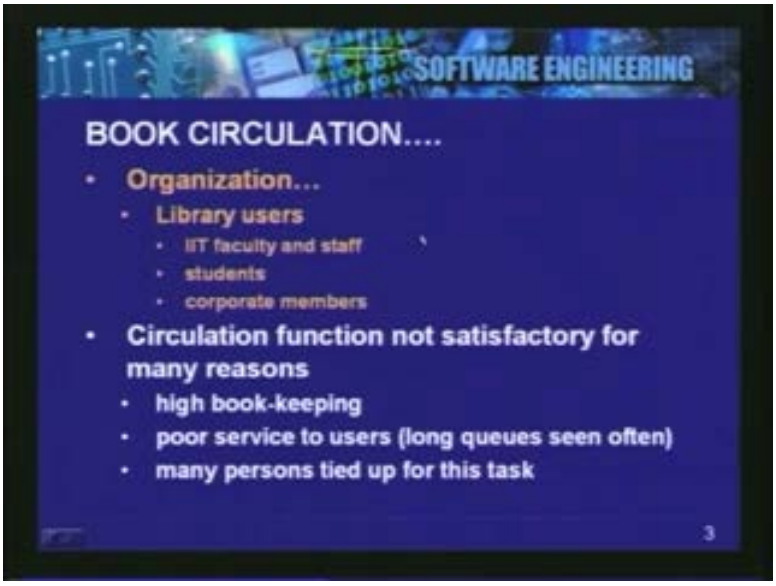

Over the years its felt that the circulation function is not satisfactory and the various reasons which appear to contribute to the problem is that the function involves lot of book keeping. Lot of records has to be kept about the books which have been issued, when they have been issued, the signatures of the people to whom they have been issued. This is the kind of book keeping which needs to be done in the circulation function.

The function also is giving poor service to the users. Very often we see long queues and many person in the library are tied up for this task. So first these reasons, the circulation function is not being considered as doing very satisfactorily. So at this point the librarian thinks that computerization could be the solution to these problems. However we should note that what is being mentioned is a solution not a problem and we have to indeed verify that this would solve the problems which we have identified. In fact we have to first established that the problems identified or indeed the once which are causing the problem or which are causing this feeling among the users.

So an analyst is called to investigate. Now in this case study the analyst or the development agency, it maybe a good idea to considerate as an external agency so that we do the development activity as a part of a contract so that the entire methodology is strictly followed and all the deliverable's are produced and the reviews are carried out systematically. So advantage of having an external agency is that the whole task is carried out in a very systematic fashion rather than doing it in house by the programmers who may not follow the methodology very thoroughly. So although here it is mentioned that somebody from IIT's computer services is called but we will assume that at every step, we will have a very definite kind of a commitment from this persons to develop the application for the library.

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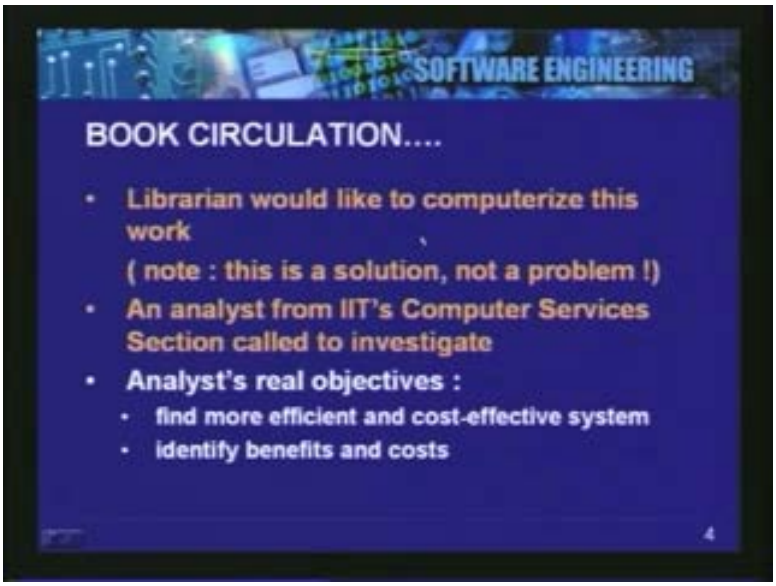

The analyst real objective at this point is to find the really efficient and cost effective solution to the kind of problems that the librarian has noticed. And one of the solution could be to identify clearly the benefits and cost. So these benefits and cost must be identified for the kind of solution that we might propose. So analyst should focused on the problem and coming up with a solution which is addressing those problems. The problem is primarily that of efficiency and cost effectiveness. So the first thing that the analyst should do at this time is that after getting a statement of problems from the librarian and doing some background checking on what kind of organization it is and what kind of activities are included in the circulation function, the next thing that analyst should do is to define the project scope.

Now since this is the organization which is quite readily understood why most of us that it is a library whose main purpose is to issue books to the users. So we know what kind of organization it is. Now we have also seen the kind of problems the librarian has mentioned now we are at this point trying to given idea of the scope of the project to the librarian. How much made cost to the library to solve such a problem and where computerization could be a solution. So at this point library indicates that it can spend about 5 lakhs rupees and we can thing of in house development where we will save on the cost of development that we need to pay to external agency. If you have in house programmers then they are already on job and we will not have a separate salary component in the cost. But in this case let's assume that the development agency is the separate one and the user in this case indicates that his budget is up to 5 lakhs rupees.
So is this a reasonable cost? Can the project really be done in the amount or something close to this amount which has been indicated by the librarian.

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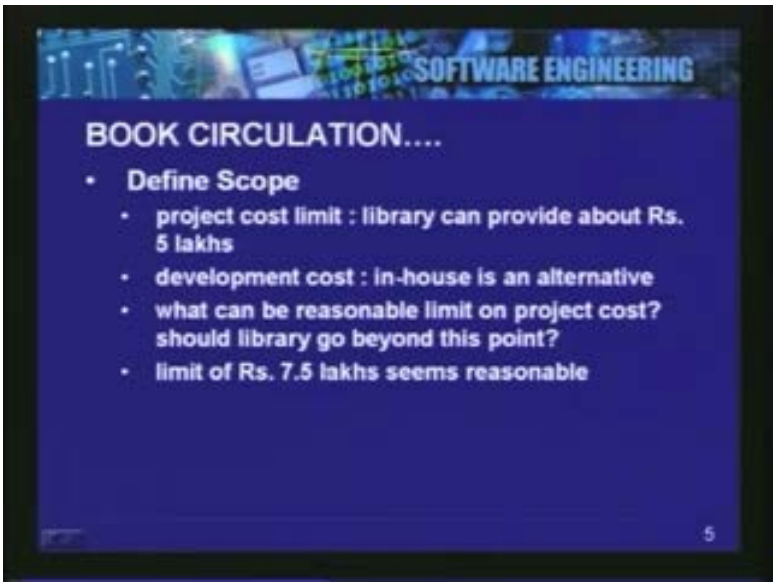

Should the library go beyond this point at all? So for example if the analyst feels at this point that a system like this based on this past experience may cost something like 50 lakhs rupees then there is just too much gap between the resources available and the resources required and therefore it may be best not to proceed beyond this point. But at this point the analyst indicates that up to 7.5 lakhs rupees seems to be a reasonable scope for the project and the gap is not significant and the library maybe able to find additional resources if required so that the solution can be worked out in the required cost. So at this point the analyst proposes that we can do the next step that is the feasibility step.

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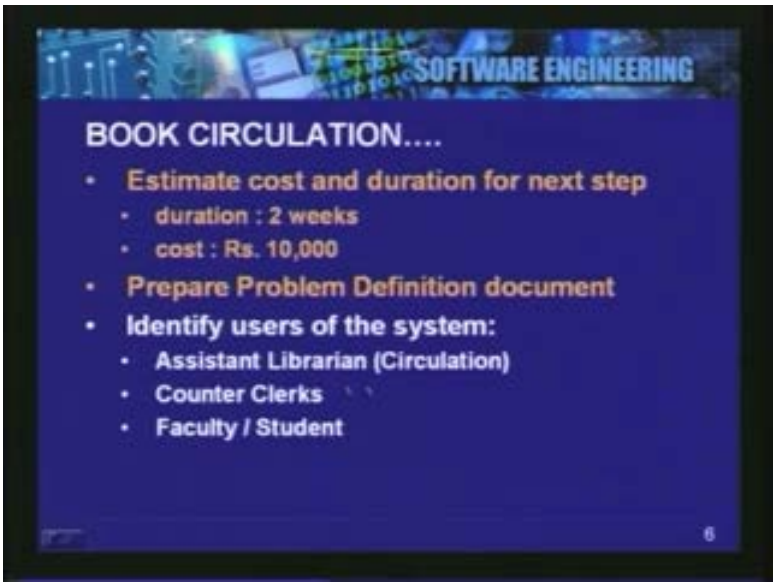

It can be done in two weeks and may cost the library rupees 10000 and if the librarian gives a go ahead signal then we can proceed for the feasibility step. At this point the short step of problem definition concludes with a problem definition document. This document summarizes the problem as we understand. So this whole phase of problem definition phase may not take in this case more than half a day or one day and at the end of which we prepare a small document summarizing the definition as well as the scope for this project.

Now we have also noted who are the users of this system, the users of this system are the assistant librarian who is in charge of the circulation function then there are a set of clerks who function at the counter of the library who issue book, who receive books and then the users of the library who are faculty and student. So you have made note of all these things and now we are ready to prepare the problem definition document. Now this problem definition document we had seen the format earlier. It's a very simple document we just give a suitable title to the project as circulation. The essential features of the problem are noted down that the present system is too slow and it is not cost effective.

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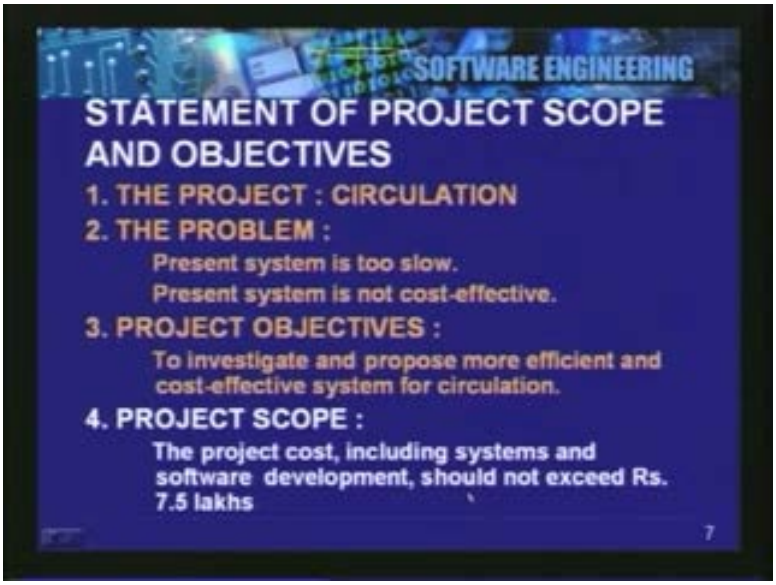

So this is actually, this becomes our reference. Any solution that we propose must address the problems which are mentioned here. What are the objectives? The objective of the project is to investigate and propose an efficient and cost effective solution and we also indicate here the scope that the project cost including the hardware systems and the software development should not exceed 7.5 lakhs and this seems to be a reasonable cost with which we can proceed further. The preliminary idea that we record here is that computerization could be a solution. In fact the analyst would have a good idea of other libraries where similar solutions might be already implemented.

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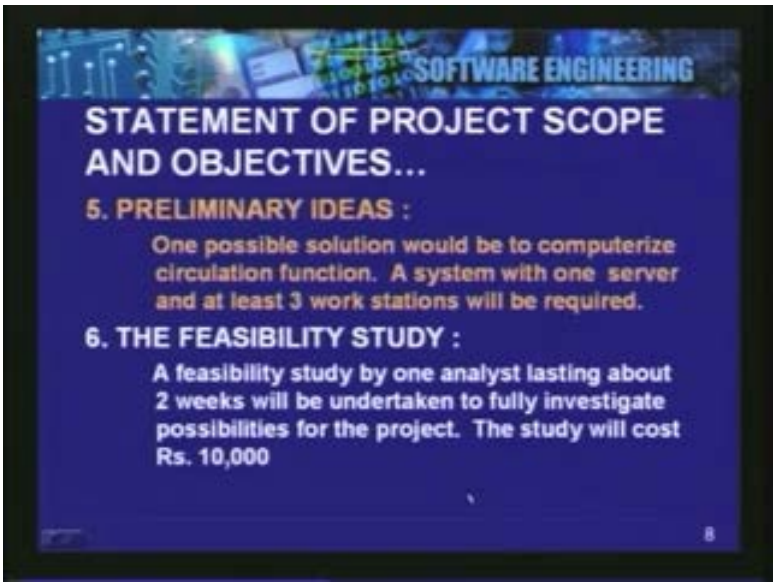

So we find that the system with possibly one server and few workstations may be adequate and this is what has included in the cost of 7.5 lakhs that he worked out. Then we record here that the feasibility step will be done in 2 weeks and we will provide a few alternatives to the user and the feasibility itself will cost 10000 rupees. So the first step concludes and it clearly defines the commitment. The commitment is only for the feasibility step and the commitment for the library is the cost of rupees 10000. So if this is agreed, the analyst can proceed to the next phase that is the feasibility step.

Now the feasibility step for the circulation project has the goal of identifying possible solutions and evaluating them and all these has to be done in limited time which is two weeks and in limited cost and effort. We do not want to spend more than what has been budgeted for this project. So keep this in mind that when the development is being done by an external agency, this time and cost will be very important criteria and they must do the feasibility keeping this in mind. So you would avoid going into unnecessary details but at the same time, you would like to come up with sufficient background of the application so that you can work out the cost, schedule, the development, effort and so on and give a few alternatives to the user. So we start by clearly understanding the objectives. We have the first problem definition document as a source for us where we had also identified who are the users.

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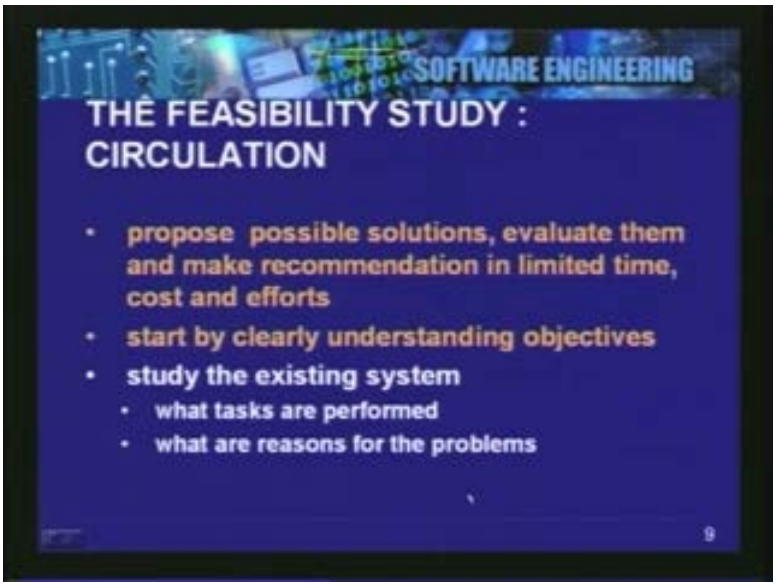

We want to take up the study of the existing system first where we would like to study what kind of tasks are performed and why is the problems failed. Why do we think or why do we feel that the present system is inefficient and it's also costly? So as we study the existing system and collect more and more data, at the back of our mind we will also try to keep those problems and see whether a logical model can be worked out for the new system which we can suggest to the user. So a some kind of proposed system is an objective of a feasibility and a few alternatives would be given. For each alternative we will analyze all types of feasibilities for those such as technical feasibility and economic feasibility and finally the phase will end by making a clear recommendation.

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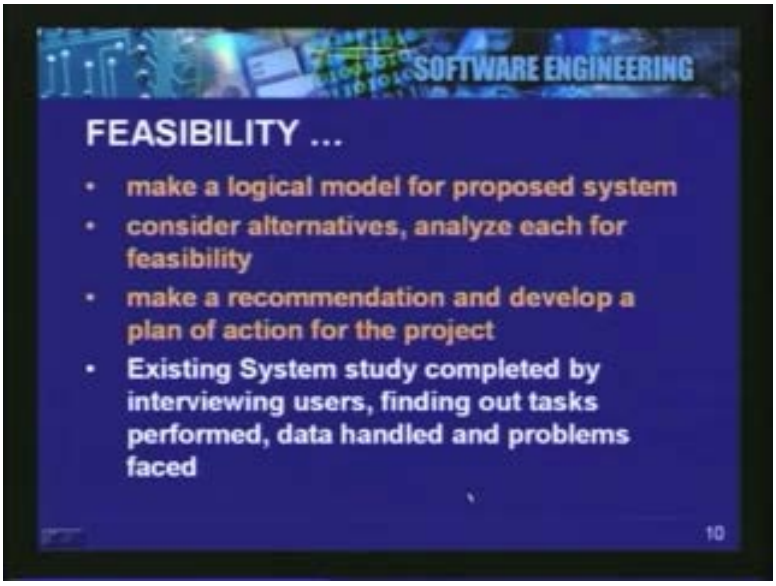

Now while doing the study of the existing system, we will naturally be talking to the various users of the system. These as we said earlier include the system librarian, the counter clerks and also the student and staff who borrow books from the library. We will try to find out what tasks are performed in the circulation function. How is the data handled and what is the reason for the various problems? So here is the list of task performed. So as we study the existing system, we get a good idea of the different tasks which are taking place. These are issuing a book, return a book, claming a book if the book is not readily available we may put a claim so that as soon as it is returned, we will be able to get that books from the library.

Next function is that when the people return books late they have to pay fine. So fine has to be computed then there are often varies from the user. They want to know to whom a particular book is issued or they may want to know how many books are issued to them and what are the dates by which those books must be returned. So number of such queries have to be handled by the counter clerks and finally we have regular reports to the librarian about the use of books and frequency with which they are kept by the users, the situation about fines and so on. So these regular reports have to be prepared. So these are the various tasks which are part of the circulation function. We also go little deeper into some of these functions to understand why the problem are failed. So we want to study the rules for circulation.

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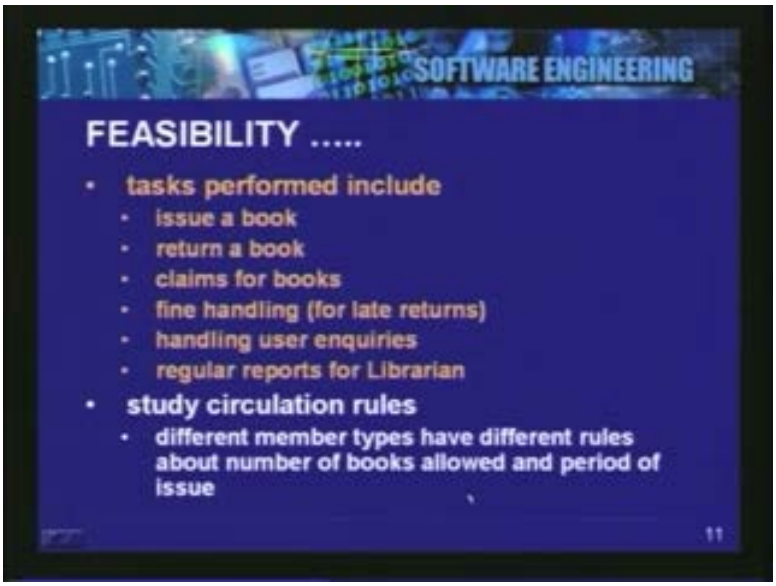

Here we see that we have different types of users so student users, faculty users, external users. These users have different rules about how many books they can issue, what kind of books they can be issued and the duration of the issue. So all these rules have to be clearly understood. So we now look at the problems phased by different types of users.
So there are users who borrow books and their complaints are that they often have long queues, so there is a poor service and especially the service about claming of books is very poor and moreover even the enquiry function is not very satisfactory.

So these are the feedback from the student and faculty who are the users. The counter clerks also tell their problems to us. They tell us that there is a excessive book keeping, they have to put a date stamp on three, four places. They have to sign, they have to verify a few things.

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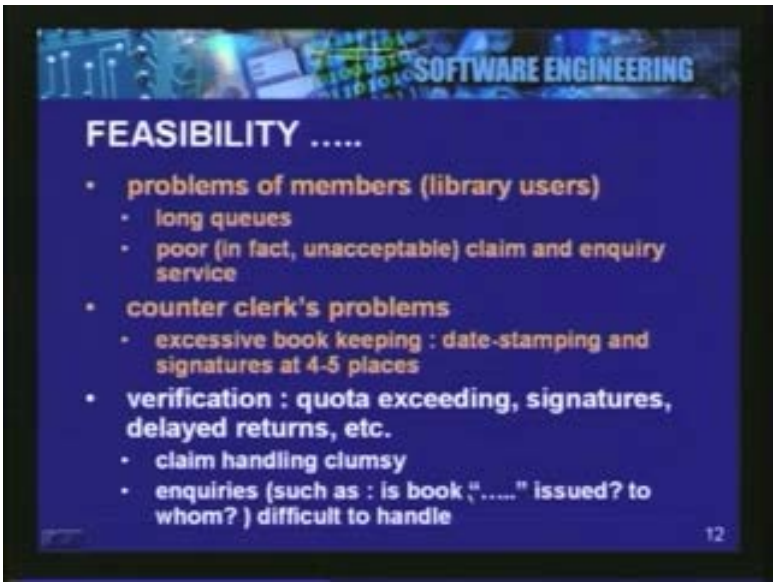

So this takes lot of times in order to complete issue or receiving of a book at the counter. Verifications include many things such as the users quota is not exceeded. For example a student is permitted to issue 5 books. So as he already issued five? Which five books here has issued? We have to match their signatures. If the return of a book is late then we have to calculate the fine and so on and all these has to be done immediately at that time. Then they also tell us that handling of claims is very clumsy because this is just done by attaching a slip to the card which represents that book. So every book has a card and on that card they put a slip indicating who has claimed that book.

Now this card is there for every book. Similarly for every member such cards are there. So this will allow us to find out which books are issued to a particular user or to whom a particular book is issued. So there are, actually there are two ways by which the data needs to be co-related. Given a book to whom it is issued and given a member which books are issued to him? These are the type of enquires because of which lot of data duplication is done and because of these duplication, there is a lot of book keeping that has to be carried out at the counter. And possibly these are the reasons which result in long queues or enquiry function not being satisfactory or the claim service not being satisfactory. We also talk to the management which is here, the assistant librarian and the librarian. And they tell us that reports and statistics about the usage of books are very inefficiently done. They take lot of time to get such reports and there is generally a problem with overdue books and the lost books.

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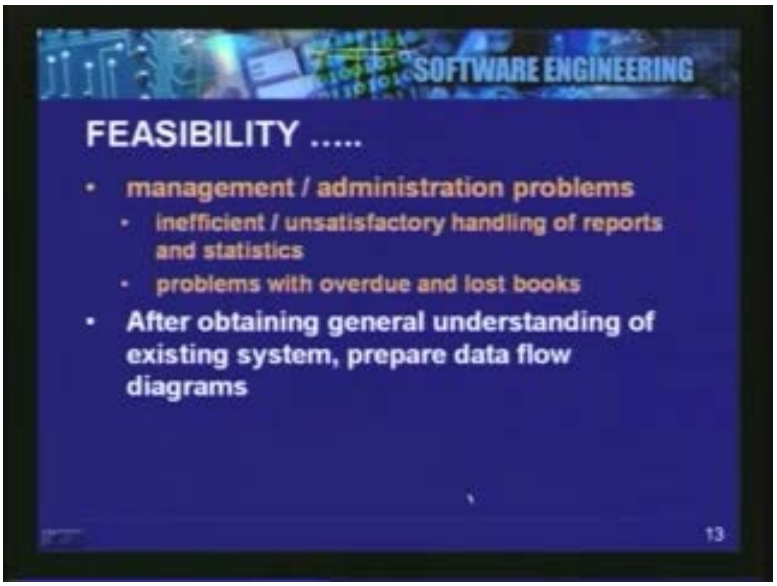

So after obtaining such general understanding about the existing system which tells us what is done and how things are done, we also find out what are the problems faced by different entities in this organization. We now try to record our findings. We use tools which will bring out our understanding very clearly. And we might in this case prepare a data flow diagram to understand what are the data involved, what are the sub stacks, what are the processors so that we get a good feel of the entire domain of the circulation activity. So here is the simple data flow diagram in which we have defined two main processors. These are the counter process where issue, return, etc all these activities take place.

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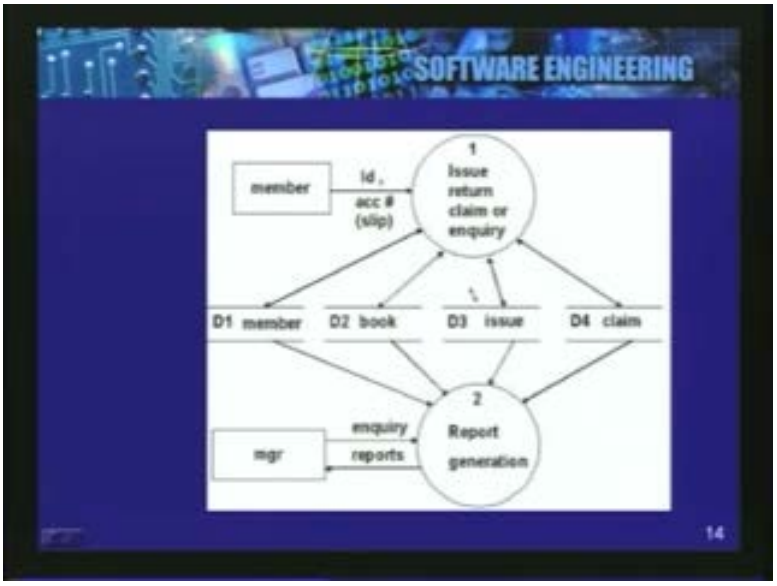

And the other function is the reporting function which to some extent is a periodic back office kind of a function which is done by different people. So we have prepared the data flow diagram which is in some way a physical data flow diagram. All these activities are happening at the counter and the counter serves the members of the library. So these members could be faculty or staff and they generally give some data such as their own identification and accession number of the book that they want to borrow. So all these inputs are given to the counter function whose tasks are issuing and returning and so on.
And reporting function might address the enquires from the librarian or the assistant librarian and produce regular reports. We also find that there are some important data stores.

Now these important data stores that we have defined here or in some sense physical as well as logical. So here we have the data store which tells us all the members who are registered with the library. These are various books which are available in library. This is the record of all issues and this is the claims which are placed by the users on the various books. So these represent the essential data that needs to be handled in the library.

Now for example this issue data may be represented in the physical library by a tray in which the cards of the books issued are kept. So how the data store looks like in the physical world is not so important here but we note here that the details of the issue have to be kept in the library. So this is the first data flow diagram but it summarizes the main activities which happen in the library. And we can refine this further if we feel it is necessary. Remember that we will not like to do unnecessary refinements because we have limited time for feasibility. Some of the important issues that come to the light now and which are possibly contributing to the problem are also noted.

One of the requirement that is important and whichever alternative we come up with must address this is that the member cards have to be seen and verified and we have to get the signatures of the people when they issue the books. Now earlier there was some duplication. We may think of some alternatives for removing that duplication. Primarily the duplication was because there where cards kept in the book which had to be signed with the name of the person who is issuing that book.

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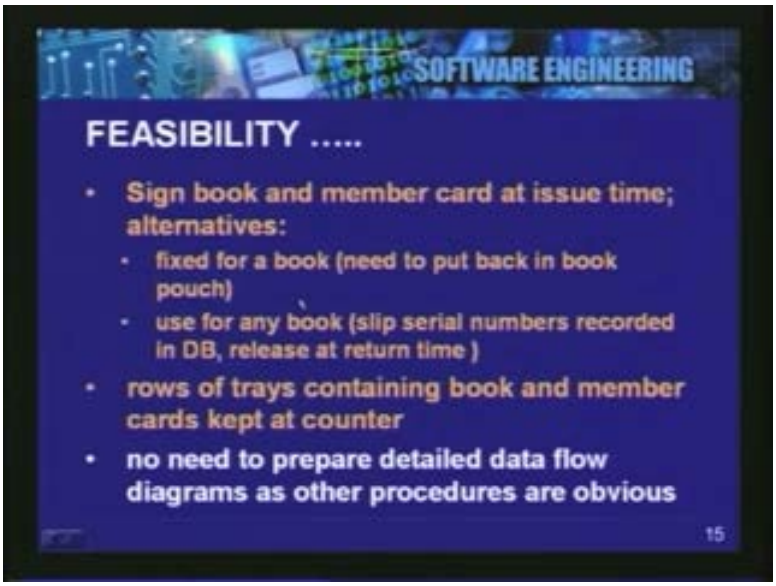

Similarly every user had a pass book kind of a thing available to him in which books which are issued to him where written down. Now this kind of duplication was necessary but it's also important for library to maintain this data. So we must remember that although this is contributing to the problem, we need to think of some good alternative so that the book keeping can be reduced. There are trays on the counter as we said earlier which contain the cards of the book or the cards of the member so that they can be quickly located in order to answers the queries of the users.

At this point now we feel that we have a very good understanding of the problem. We don't now need to go in more details, no need to prepare additional data flow diagrams or ER diagrams. We now can think of possible solution at a high level and also work out their cost benefit analysis. That is ultimately the goal of the feasibility. So we note down what are the main reasons which contribute to the problem so that we can then verify whether these are being addressed by all the alternatives that we are considering. So first reason is the duplication. The data has to be accessible both by the users as well as by the book. So if I give my user identification, the library should be able to tell me what books I have borrowed and if I give the book accession number, they should be able to tell me whether the book is issued and to whom it is issued. So this kind of duplication which is required needs to be addressed properly by the solution that we might recommend.

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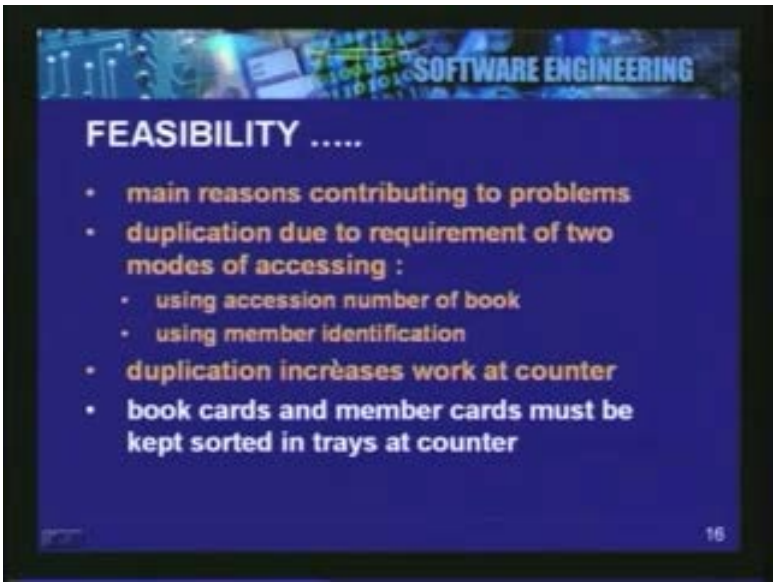

At this point we are not necessarily confining our solutions to computerization only. You might think of some other way by which this duplication can be removed. Duplication naturally increases the work at the counter and therefore they were indirectly contributing to the problem because these card have to be kept, they have to be kept sorted and then you have to have people at the counter so that they can look up these trays and answer your queries. So all this problems actually indicate both the inefficiency and the high cost for this function because too many people are tied up for this activity. So this is basically the point that we just now made that the trays have to be searched and when a book is returned we have to take out the card of the book, take out the card of user we have to cancel them and so on.

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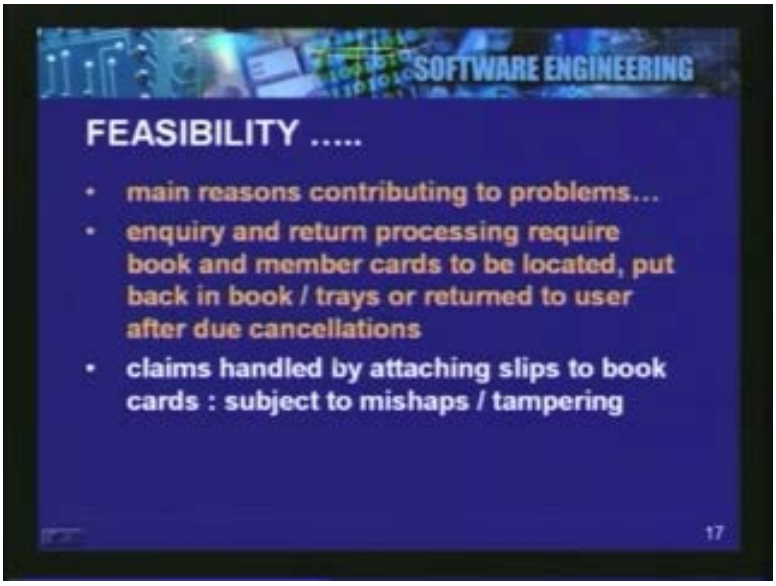

So these activities take time and therefore a queue of people easily builds up. Claims where handled by attaching slips and this is obviously not a good solution because the slips can drop off and there can be some kind of a problem for the claim processing. So we have noted these main characteristics. The main characteristics are that it's a primarily an online system. Because the users come to the counter and they want the books to be issued and written in formant of them.

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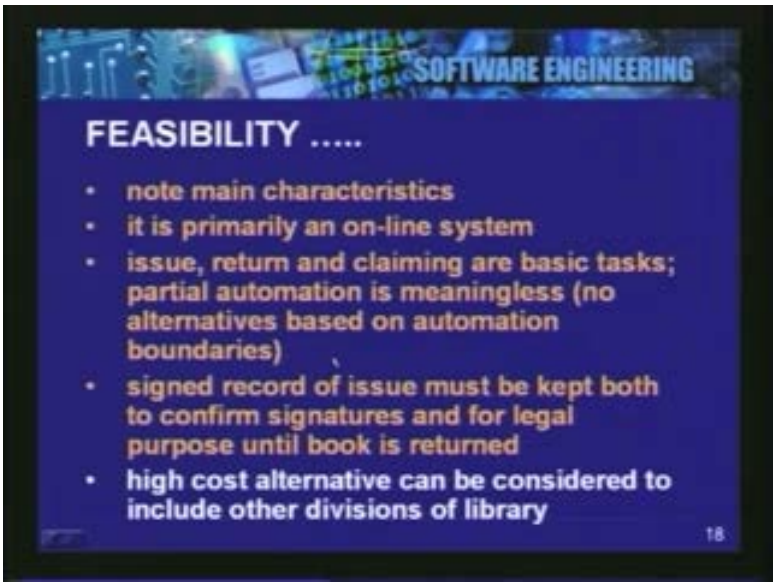

So it's an online system. Issue return and claims are all basic tasks. You cannot automate a few of them, either all needs to be done or it probably can be left as a manual system.
So partial automation is meaningless in this case. So we cannot consider alternatives based on the scope of automation. And another important characteristics are that signed records have to be kept. We might think of some high cost alternative where you might go beyond the circulation function and you might include other functions of the library.
But circulation itself is a fairly self-contained kind of a task and either we automate all of it or leave it completely as manual. So at this point now we can think of some solution to the problem. We can work out some alternatives which are probably alternative in terms of technology. We said earlier that we do not have alternatives here in terms of the scope of the function.

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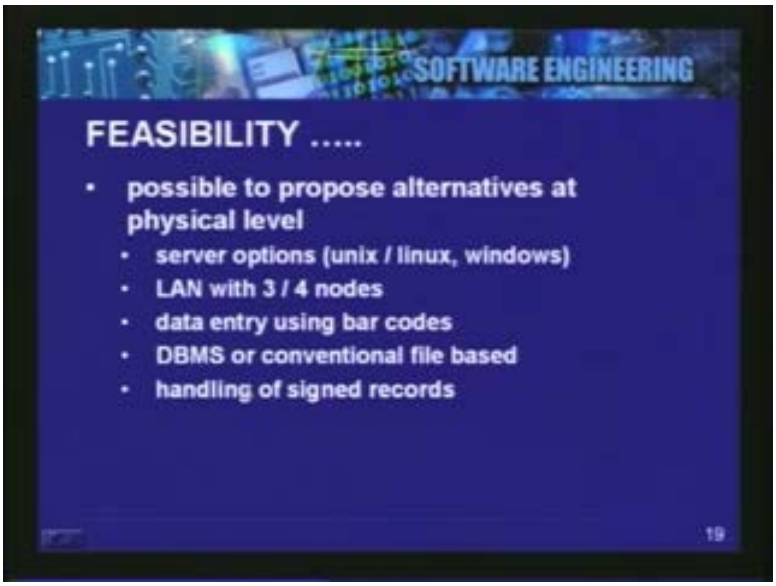

So we might think of some technical alternatives which are listed here. We may have different environments for the server or we may have data entry which is done through bar coding. We might use a DBMS or conventional file systems and we might have a few alternatives about how we verify signatures and how we keep this data about the signatures. So based on this we can work out a few alternatives which might have different cost and different benefits. So we can now also prepare a logical data flow diagram for each of the alternatives.

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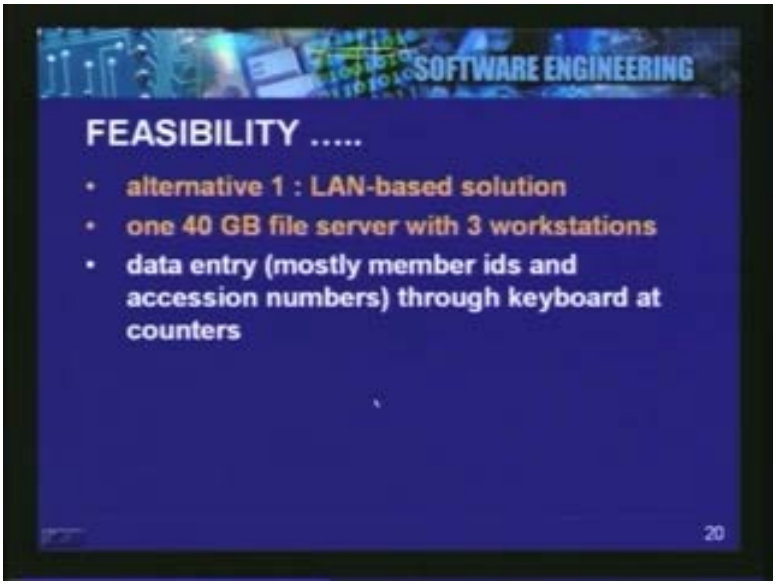

Now let's consider a two alternatives in this case. The first alternative is a LAN based solution where we will go for one file server and few workstations and at the counter, we will assume that the data entry is done by the counter clerks directly. Now this data entry is really not significant. Most of the time they have to enter the identification of the user or the books accession number when the issue or return is taking place. So we could consider an option where the data entry at the counter will be manual. In this case what kind of costs are involved.

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So we use our experience in working out the cost for such an environment. So we find that the server and operating system or other whatever that needs at the various work stations might cost as about 4 lakhs rupees. The database management system might cost about 20,000 and the application software development will cost as about 30,000 rupees and one of the important component of this could be initial data entry for all the books that we have in the library and the existing users of the library. Now this is the significant one time cost which is required in order to go live, if we are doing computerization.

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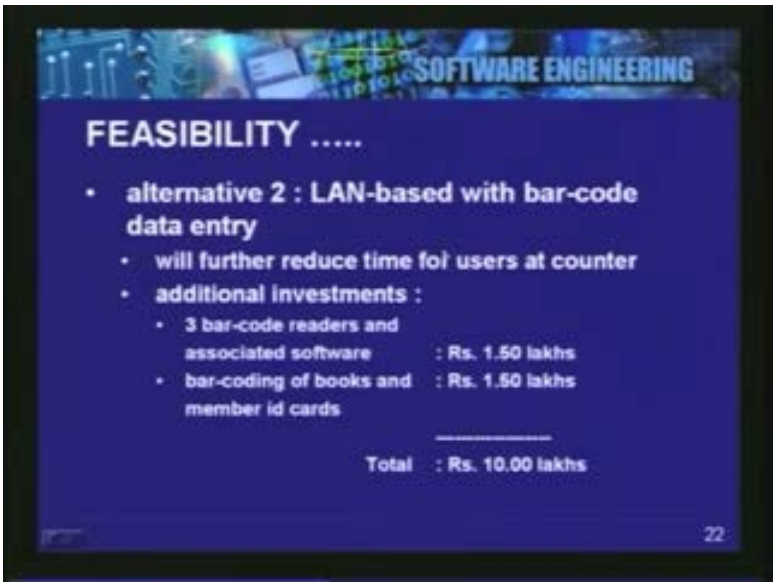

So all the data about the books and the members must be online. This might cost as about 2.5 lakhs. So the total cost of the system is about 7 lakhs rupees. We consider second alternative where instead of doing the data entry manually at the counter, what we would like to do is to use bar coding so that books can be bar coded as well as the members identity cards can be bar coded. So this will avoid data entry time at the counter. Moreover it may also reduce errors which takes place at the counter. So in this case there is some additional investment required, 3 bar code readers may have to be purchased that might cost additional 1.5 lakhs. And there is a cost of bar coding the books and member identity cards. So this is another 1.5 lakhs and the 7 lakhs of the systems and development. So the total cost for alternative 2 becomes 10 lakhs rupees. We now examine each alternative for feasibility. Both alternatives are obviously technically feasible as well as operationally feasible.

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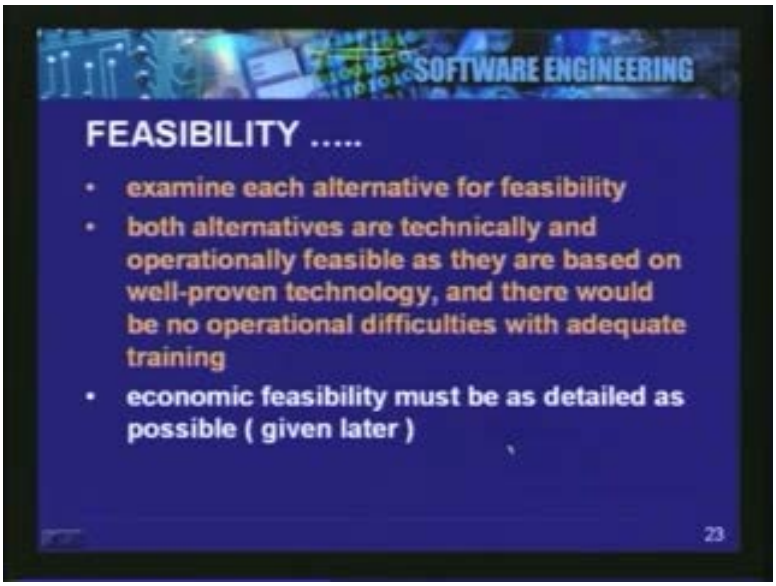

So what we really need to look at is the economic feasibility and work out whether the two options that we have, which one of them is more cost effective and whether it is worthwhile to take up this project at all or we can find better ways of spending this money 7 lakh or 10 lakh whatever the alternative implies. So economic feasibility will establish how good is the investment, whether the project is worth doing and what kind of benefits we can look forward to in each of these alternatives. So before working that out, we may ask ourselves have we given enough number of alternatives. Are there low cost, medium cost, high cost kind of alternatives given to the user.

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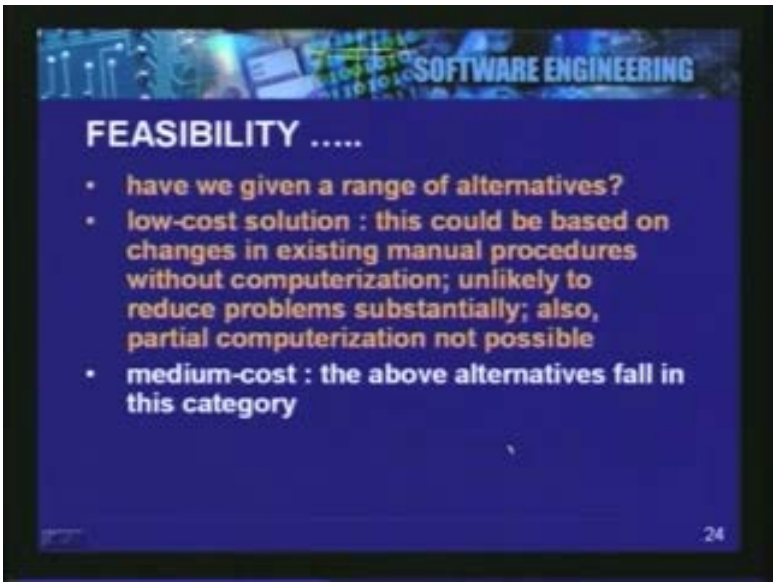

Now there can be a low cost solution which can completely avoid computerization. It might reexamine the kind of record keeping and the cards system that we are using and might replace it by something else. We have noted earlier the partial computerization is not possible. So a low cost solution might be considered. The medium cost solution is what we have discussed earlier, the two solutions fall in this category and we can also think of some high cost solution. We can also think of buying a product which might be available in the market which may do something more than circulation. It might even take care of book acquisition system. So we can look at different range but in this particular exercise, in this case study let us look at the two alternatives that we saw and analyze them.

So let us consider the financial analysis for the first alternative which has the initial cost of 7 lakhs rupees. Now what are the benefits? Can we quantify them? With quantification we will be able to establish whether it is a beneficial investment or not. So here we have tried to work out the benefits. So we say that with this automation, we will be able to save on salaries of four people because we will not need so many people at the counter and those trays will not be required where the cards have to be sorted and cards have to be pulled out. So out of 7 people we can reduce 4 people giving us the saving of 1.92 lakhs.

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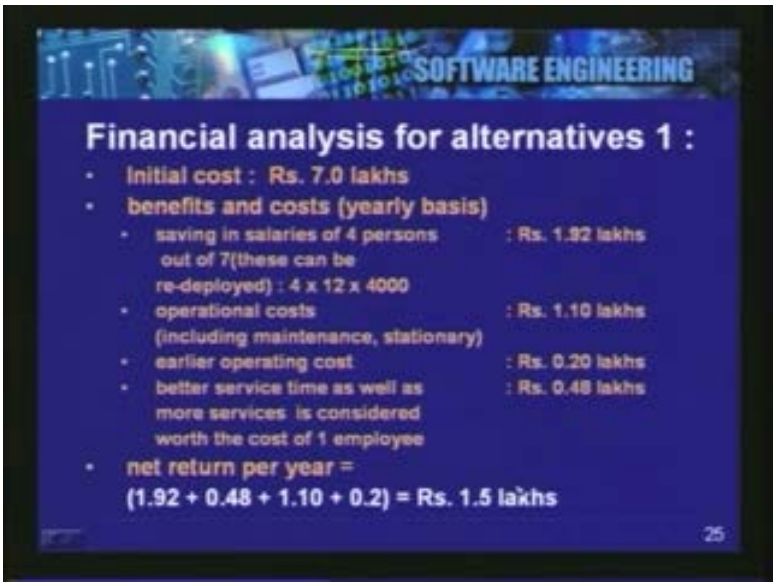

In the new case the operational cost will be about 1.10. This operational cost includes the maintenance of the computer systems and other cost. Earlier the operating cost was only 20,000 when we are not using computers. So the operating cost has gone up but we are saving on salary and we also want to quantify the better service that we will be able to give to the users of the library. This will, the alternative will reduce the waiting time at the counter. Now we want to quantify this and the best way of quantifying this is to ask the librarian that with improved services, what will we consider this service to be worth?

So here the librarian may indicate that this kind of efficient service that software may give probably can be obtained by employing one more person. So we can think of it as a benefit which is equivalent to the salary of one additional employee. So we work out now here, the various benefits and the different cost. So in this case the net return, the net benefit works out to about 1.5 lakhs rupees. So our investment is 7 lakhs rupees whereas every year we will be able to save about 1.5 lakhs rupees. So how good is this investment? Now these invest… you must remember that the benefits will come to us in the subsequent years and every year there will be a benefit of 1.5 lakhs. We must bring the future benefit to the present value and in order to do that we must know what kind of interests rates are available.

So if let's my benefit at the end of first year is 1.5 lakhs rupees, how much do I need to invest today with the interest rate which we will give me 1.5 lakhs at the end of one year. So this is how you calculate the present value and we have used here the interests rates of 12 %, of course these keep changing and if the interest rate is lower then in fact the benefit will be higher that is the present value of the benefit will be higher.

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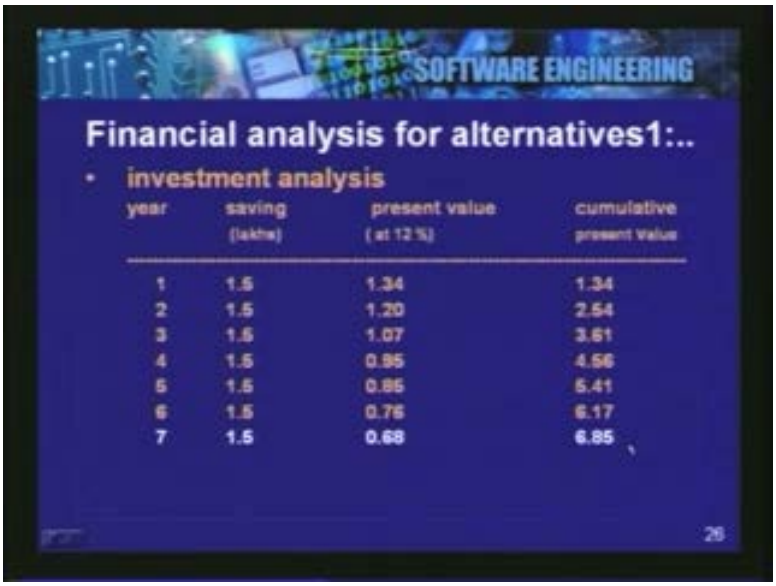

So here as you see at the end of first year when I get the benefit of 1.5 lakhs, its present value is actually only 1.34. So we do this for all the years which represents successive operations of the system. And the last column here gives the cumulative value of the benefits as of today. So as you see here at the end of 7 years of my total benefits have a present value of 6.85 lakhs whereas my investment affront as of today is also 7 lakhs. So we are brought both of these, the investment as well as the benefit to the same point in time. Our investment is 7 lakhs and our present value of all the benefits is 6.85 lakhs. So if you assume that the system life is of 7 years then we get the benefits of 6.85 lakhs and the present investment is 7 lakhs. So we just about break even in 7 years that means we get back our investment in 7 years.

However we should remember that even if we discard the system at the end of 7 years that is if the useful life of the system is 7 years and we discard it, still we don't in future have to do the data entry of books again which means that the 2.5 lakhs investment in the data entry of books is protected.

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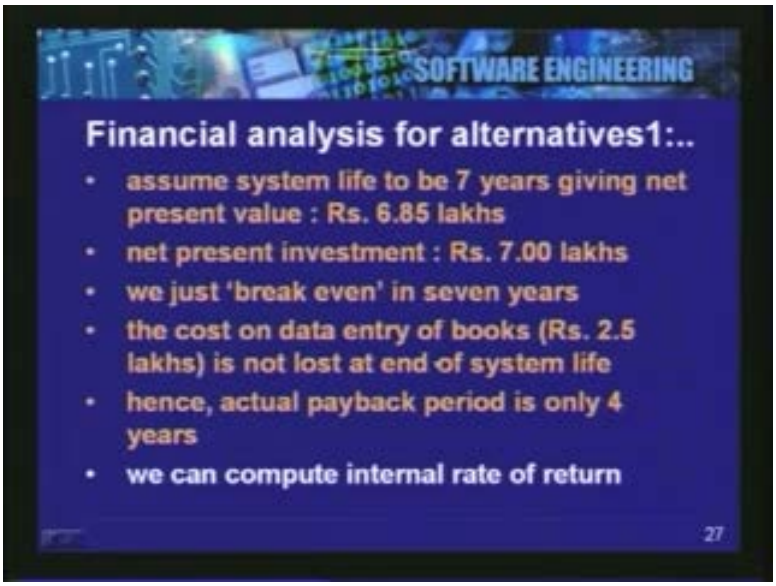

So we should consider the break even to be much earlier than 7 years. In fact it works out to be 4 years in this case. Because even when we switch over to something new, we will be able to save this cost in future. So we can note down all these cost and benefits and we can see how good is this investment. Usually this is done by calculating the internal rate of return which is the good indicator of evaluating different investment opportunities.

The alternative two in this case you know, we also again try to work out what are the benefits. So there are benefits in saving of salary which is same as before. But the operational cost goes up because we have to include the maintenance of the bar code readers and so on. And improved service in this case is considered to be actually better than one person. We are saying that it may be treated as one and half person worth, so in this case we take it as 0.73.

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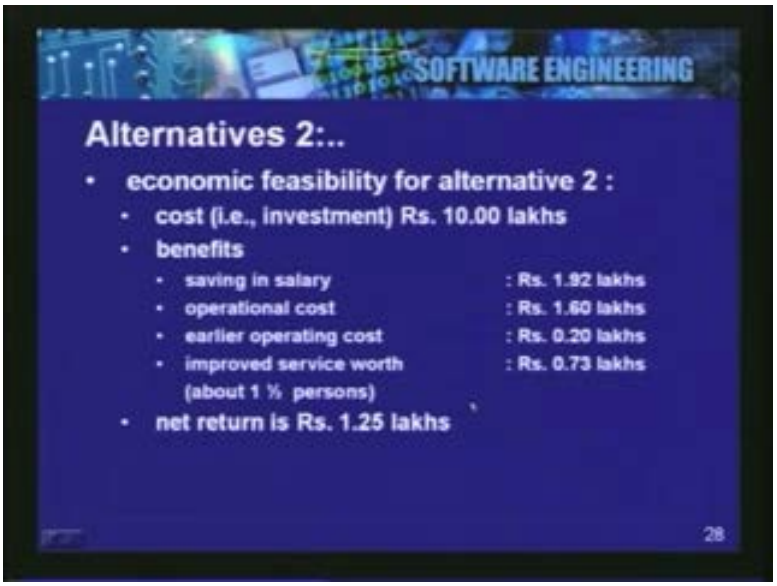

So in this in alternative 2 the net return comes out to be 1.25 lakhs. In fact this is lower than the alternative one. So we have more investment but less return and therefore economically alternative two may not be considered most cost effective. However you may still recommend it because of its impact value. you would be using bar coded books and bar coded member cards and this will be considered as the state of art technology and it has a better impact and this may be an intangible benefits that you may like to consider.

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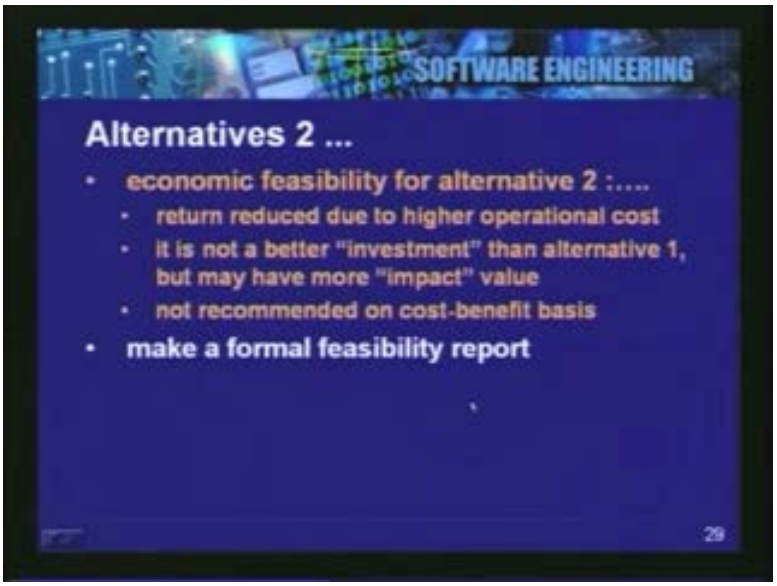

But purely on cost benefit analysis, you might consider alternative one to be better. At this point you make a formal feasibility study report and you present it to the management. But before that you also work out a plan, the possible plan for implementation for the subsequent phases of the project.

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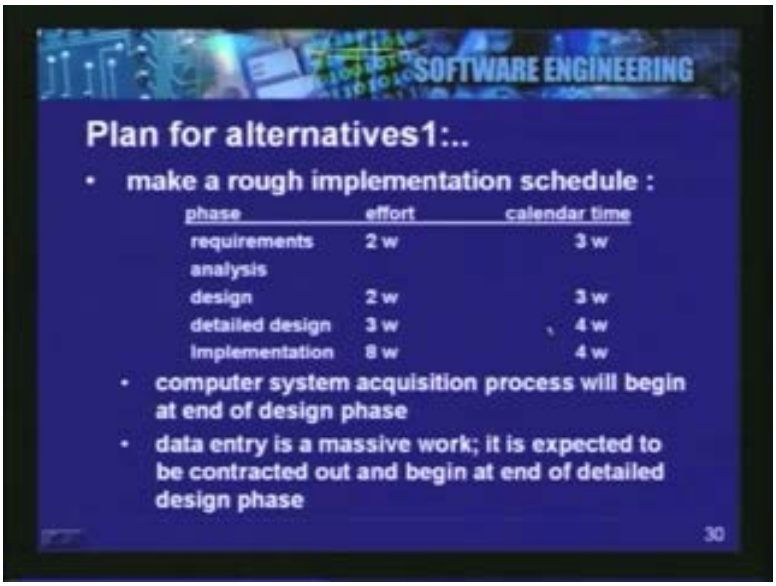

So we will be doing requirement analysis, we will be doing design, we will be doing detailed design and implementation and we work out both the person effort and the calendar time for carrying out these activities. Based on which the library would know in what time period, it can expect the system to go live in the library. So here we have given calendar time for each of the important phases. Then we have also note down some important points that the computer system acquisition will begin at the end of design phase where we will clearly know what kind of a platform and sizes will be required. We also noted that the data entry is a massive work and we want to contract it out and not do it through develop software development agency but give it to some data entry agency and this work will begin at the end of the detailed design phase. So that by the time we complete coding of the software and testing, the data entry would have been also completed.

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So all these activities can be put down in the form of a implementation plan. So we now finalize our report, we make a presentation to the users and to the management. Let them consider the different alternatives to the cost benefits and they will clearly tell us which is the right alternative for them and which is the alternative they are willing to commit the cost for. After this assuming that alternative one has been accepted by the users, we will now proceed towards the requirement analysis phase. In this phase our idea, our responsibility would be to determine what exactly the system functions are.

So the details of what the system needs to do would be defined as a part of requirement analysis. We will do this by defining the various inputs to the system, the outputs and the processing requirements and this must be detailed enough to complete the design subsequently. We will start by examining the feasibility study report that we had prepared earlier which contained a few data flow diagrams so we can make use of those. And now we will expand them in more details. During feasibility we have got some idea about the organization and the circulation function that the library performs.

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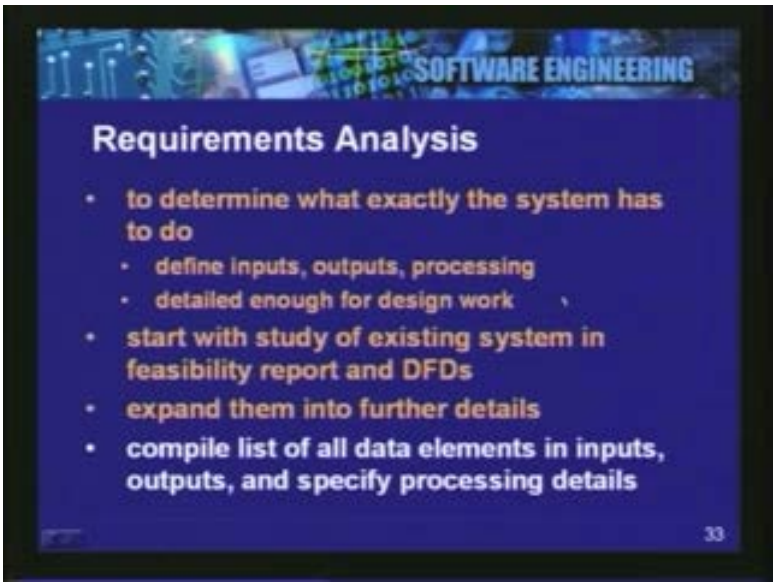

So we build on that and now go into more details and also identify how the things can be defined for the proposed system, in terms of the basic activities required by the library. As we do this, we will collect lot of data and we will compile a list of all specifications which relate to data elements in the input, data elements in the outputs, computation that need to be performed such as how do you calculate fine. And is the rules for fine same for all different types of users. All these details will be noted down in some kind of a repository as we investigate the problem now in more details.

At the end of requirements analysis, we will prepare the requirement specification document which as we had said earlier is the first base line of the project which is one of the most important document which tails the user, a kind of system that will develop for him. After the SRS is done, we will have a review of that SRS with the users and also will have a peer review where other analyst would examine the format as well as the content of the SRS document from its completeness and consistency point of view.

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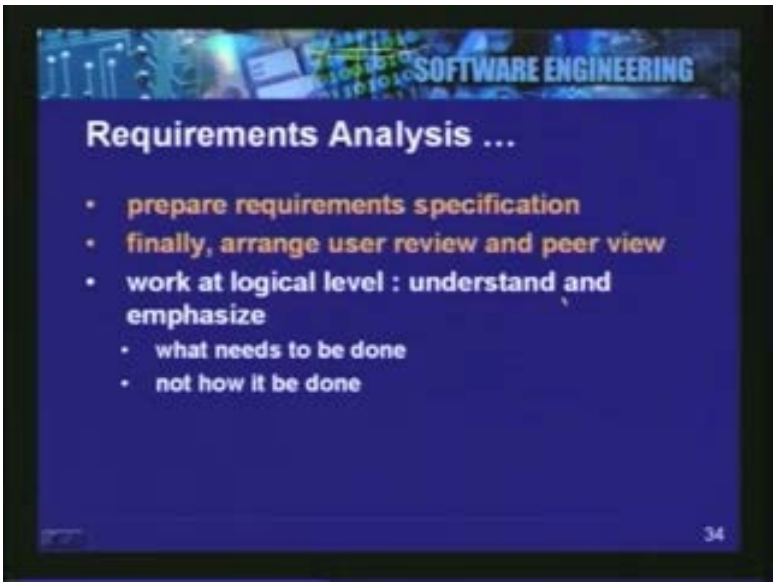

At all the time we must work at the logical level. We must understand what needs to be done and we should eliminate those aspects which are implicit which are being implemented in the current environment, which is the manual environment. We would be naturally changing some of them. So what is more important is what needs to be done and not focus on how things are being done today. As we go in more and more details, talking into users, following through the various manual operations, examining the various data which are kept in files or cards or whatever, we have to systematically store on the findings and also creates models through which our understanding can be properly recorded.

So we may use data flow diagrams, we may use some kind of a data dictionary tool. This tool is an ideal tool for recording various descriptions. Let's say what does an input consist of, what does an output consist of, what is the particular computations? All those details can be stored in a good data dictionary tool.

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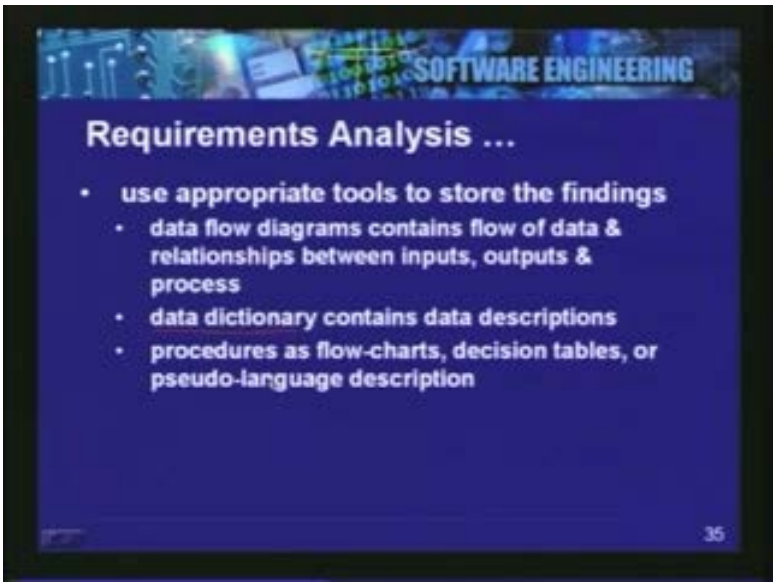

We might also use other tools such as flow charts or some kind of a pseudo programming language to describe the algorithmic part of how things are done, like you might prepare a pseudo language description indicating how fine is calculated. So this is the context diagram for our system where the primary users are the members that is the student, staff and so on and the librarian.

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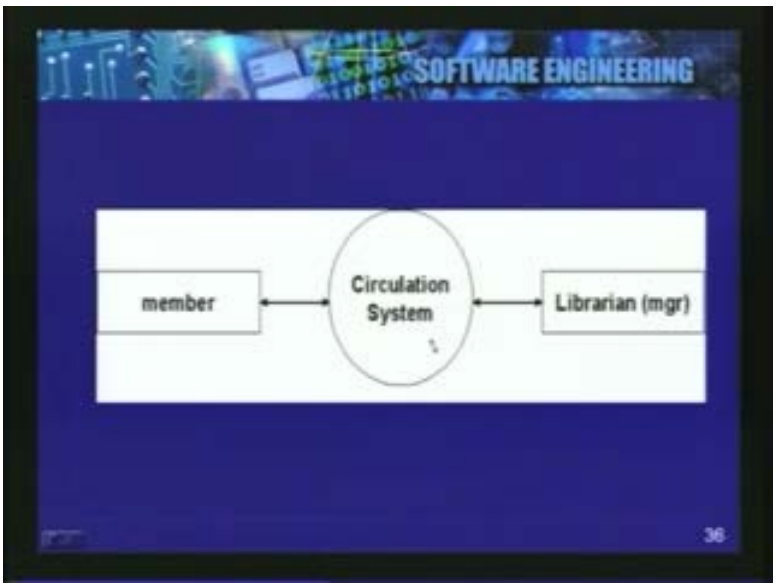

Note here that we don't show the counters clerks as the user because they are primarily the intermediary users.

When these when a student approaches, he approaches a counter clerk in order to give his data and the role of the counter clerk is only to enter that data. So they are really not direct user of this circulation system. They are basically intermediate entities who take the data from the members and process the transactions on the system. So we then repair our first level data flow diagram by decomposing the previous context diagram. And if you remember this is the diagram roughly which we had prepared during the feasibility analysis itself where we have counter functions as for being processed one and report generation as for me the process two and we had also identified some of the data stores.

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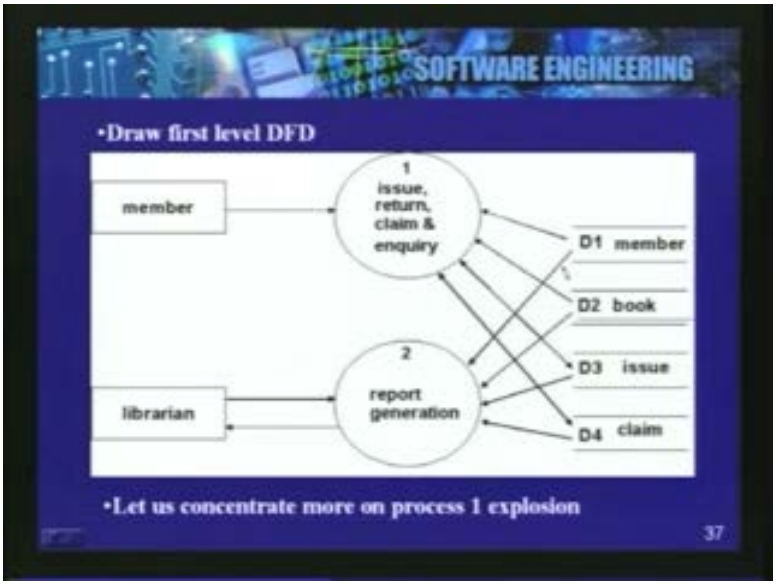

Obviously lot of things are happening in process one and you might one two decompose this further. The purpose of decomposition is to understand which of these data stores are required by these different sub tasks. Maybe all of them are required or the way they are required would be different in each of these.

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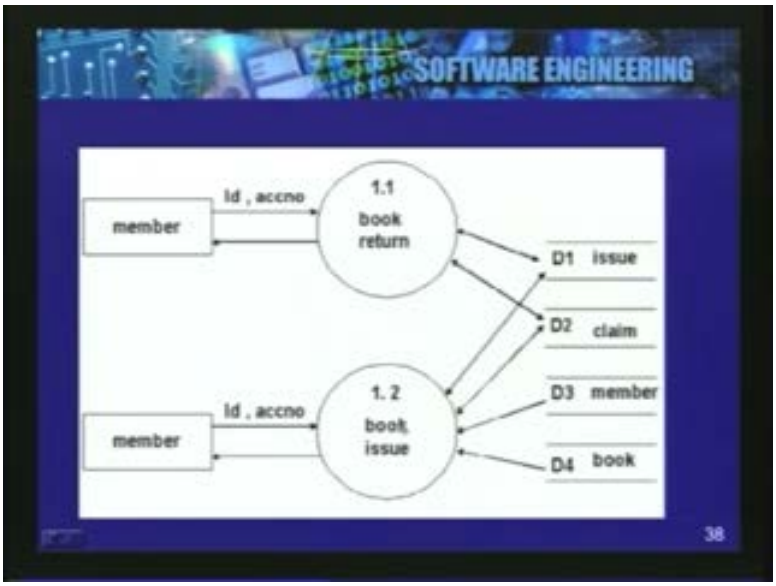

So you might consider decomposing process one further. Here is the decomposition. We had broken it into 1.1 which is only the return process, 1.2 which is the book issue process. As you see here the book return is only dealing with the issue and the claim and the book return is dealing with issue and claim. Because when the book is returned we have to cancel that book and when the book is returned we have to see if it is under claim so that the new user who wants to the different user who wants to take that book can be informed. So book return seems to be using these two data stores whereas the book issue seems to be using all the data stores.

Further you see that the book issue is using member and the book only for retrieval purpose but it updates the issue and the claim data store. So we see here that as we decomposed, we now not only indicate which data stores participate in a process but in what way they are used whether they are input or whether they are output. And we also indicate the exact data which is being obtained from the member for that particular process and this is the book claim.

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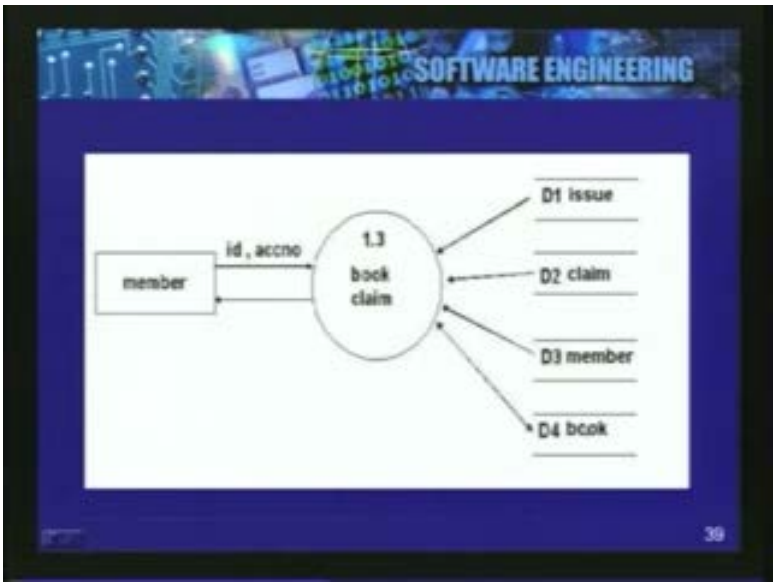

As you see here, the book claim function is using all the four data stores. In fact the book claim is noted with the book therefore the book is also shown as participating in both input as well as output operation for this process. So this way we are expanding each of the task. Enquiry, subtask naturally will use all the four data stores without updating any of them and it will address the different quires of the members.

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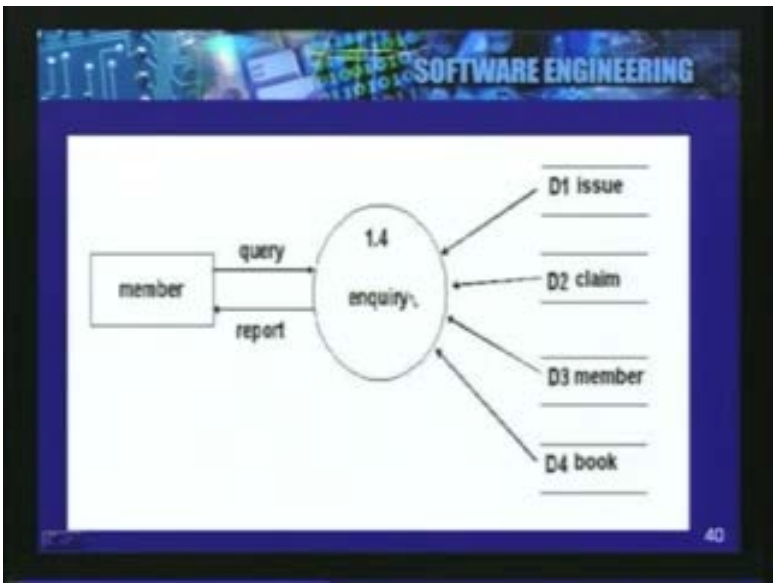

Now after we have done the decomposition of the data flow diagram to sufficient level, the next thing that we should do is to understand all the data stores very clearly. And this must be done by identifying for each data store what fields or what attributes is

contained. So if you look at this data store book, what are the attributes of the book which are of interest to us?

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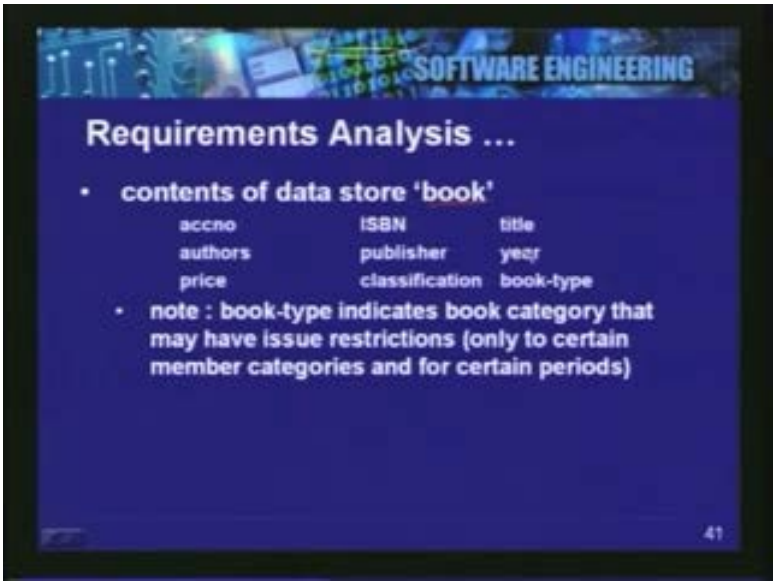

So we note down here that accession numbers, authors, price, ISBN, publisher, classification, etcetera are all important to us and we would like to record these in the book data store. Of course as far as the circulation function is concerned, accession number will be the most important. Because this could be the one based on which books will be issued and return. However other attribute that we are identified here are important from the enquiry point of view and they must also be noted. The important attribute book type here. Now this book type is also very important. The book maybe a reference book, a book maybe a general reading book. Depending on the type of book we may have different rules. A reference book maybe issued only for three days and it may be issued only to faculty. So we identify the important attributes for every data store that we had identified in the data flow diagrams. We have indicated here for the book data store but you should we should identify all such attributes for the various data stores that we had seen in the previous data flow diagrams.