Computerizing Large Systems: Lessons from an Application

Abhimanyu Singh

Large volume data systems, such as the tabulation of university examination results, often conceal innumerable exceptions and complexities, accumulated over the years. Handled manually with flexibility and ease and along with the large volume of routine, they can wreck poorly conceived computer applications.

Abhimanyu Singh narrates such an application, namely, computerizing the tabulation of examination results of the University of Rajasthan in 1982. Instead of cutting the delays in the announcement of results, computerization added to the delays and complicated it with many errors.

Abhimanyu Singh analyses that experience and provides the highlights of the steps taken from 1983 onwards to remedy the situation and make a success of the application. He contrasts the approaches taken towards computerization in 1982 and from 1983 to 1985 to arrive at useful lessons for computerizing large data systems.

The experience of computerizing examination results in the University of Rajasthan shows that an ad hoc approach to computerization of large data systems can be hazardous.

The situation involved the use of hired computers on a contract basis for accomplishing a time-bound task. A number of government and semi-government bodies in India are adopting this strategy to gain access to computers. This initial period, prior to developing own capabilities, is viewed by organizations as a time to survey the market, gain familiarity with computers, select the performance areas and tasks for computerization, train and recruit computer personnel and introduce changes required for conversion from a manual to a computerized system.

This period became a nightmare for the University of Rajasthan. The application of computers for tabulating the 1982 examination results brought the University close to the loss of a whole year for over 300,000 students, instead of speeding up the announcement of results. I give here an account of how this happened, contrast the 1982 experience with the University's successful experience subsequently, and draw some lessons from the computerization of large systems.

University of Rajasthan

Up to 1987, the University of Rajasthan was a teaching-cum-affiliating university with responsibility for conducting examinations every year for over 300,000 students spread across 200-odd colleges. In 1982, when the computerization of examination results was introduced, the university was conducting 300 examinations annually for which 2,500 question papers were set and 500,000 answer-books assessed by about 15,000 examiners. The administration's task was enormous.
Examination Process

The examination process virtually commences with admissions in July every year and proceeds step by step in around 60 different stages until the declaration of results a year later. These stages are so intricately linked with each other that any delay in completion of one stage results in dislocation of the entire process.

Background

By 1982, the University's reputation for conducting annual examinations on schedule and declaring results before the commencement of the next academic session in July had received a serious setback. Established in 1947, the University had grown over the years in terms of number of colleges affiliated, number of students enrolled, number of students examined, and the number of examinations conducted. This phenomenal growth was accompanied by a proliferation in the types of faculties, departments, subjects offered and combinations permitted. Under student pressure the University had permitted the carrying over of 'backlog' papers to higher classes and re-examination in the case of papers 'boycotted' by students. This had grown into administratively unmanageable proportions. Student unions had also made it a practice to demand and obtain postponements of annual examinations on one pretext or another.

Student indiscipline, employees' agitations, non-cooperation by teachers and administrative mismanagement had made the situation worse. The staff of the Examination Branch, which was responsible for the smooth and successful conduct of annual and supplementary examinations and for timely and accurate declaration of results, would hold the University administration to ransom at will. They would demand exorbitant overtime payments for checking of application forms, issue of permission letters and admission cards, proof-reading of roll-lists, and preparation of tabulation registers and mark-sheets. If their demands were not met they would adopt deliberate 'go-slow' tactics or strike work at critical stages.

The University administration had been too soft and accommodating to trade union pressures from students and employees. It was also guilty of not being able to exercise close and effective supervision, monitoring and control over the numerous stages of the examination process. There was little coordination between the University authorities and the affiliated colleges and between different sections of the Examination Branch. Due to absence of advance planning and lack of indepth understanding of the entire examination process, there was a tendency to go in for last minute ad hoc solutions as and when problems arose. The general laxity in managing the University had allowed the teaching community to get away with violation of deadlines for examination work. This led to delays in:

- approval of panels of examiners
- paper-setting
- assessment of answer-books
- despatch of award-sheets
- receipt of answer-books
- tabulation of results.

Due to the absence of effective monitoring and control, the printing presses also took their own time to print roll-lists, numerical rolls, question papers, tabulation registers and mark-sheets.

Past experience had shown that introduction of reforms in the examination system of the university was a difficult and complex job. The track record of unsuccessful reforms and the lessons learnt from them ought to have been borne in mind before embarking on a major reform such as computerization of the entire examination process.

New Leadership

The academic session of 1981-82 saw a change in the leadership of the University. The new Vice Chancellor and the new Registrar were faced with a formidable challenge which they were willing and eager to meet. The University reopened two months behind schedule on September 15, 1981 and results of the 1981 annual examinations were declared as late as October of that year. This led to delay in admissions and enrolment. Due to lack of planning and malfunctioning of the University Press, printed application forms for appearing in 1982 examinations were not supplied to students in time and the dates for submission of the forms had to be deferred up to December 1981. Supplementary examinations and re-examinations of boycotted papers were also held way behind schedule. This made the conduct of examinations on schedule from March to May 1982 extremely difficult. The University administration was under
great pressure from the community and the Government of Rajasthan to do something drastic to remedy the situation.

Decision to Computerize

It was in these circumstances that the decision to go in for computerization of the examination process was taken. It was a response to a rather desperate situation and a resolve on the part of the Vice Chancellor and the Registrar to set matters right. In taking this important decision, they were influenced by the successful use of computers by certain universities and school boards for processing examination results, high-pressure salesmanship by some computer firms, and a widespread belief that computers were the ultimate solution for administrative tasks requiring sorting, processing and analysis of voluminous data in a time-bound sequence.

Policy Process

Computerization of examination work had been successfully initiated in the Universities of Meerut and Delhi. The former Vice Chancellor of Delhi University had returned to the University of Rajasthan as Professor Emeritus and was a close confidante and adviser of the Vice Chancellor. He was of the view that computerization had brought about considerable efficiency in the examination system in the University of Delhi. It was he who inspired the Vice Chancellor to think in terms of computerization of tabulation of results and other related work. At his instance, some officers of the Examination Branch were put in touch with their counterparts in Delhi University and the Controller of Examinations was asked to explore the possibilities of computerization.

Computerization

In December, 1981, officers of the Conduct Section of the Examination Branch submitted a note to the Registrar that due to non-availability of printed application forms, the colleges had not been able to submit application forms on time. If examinations had to commence on schedule in March 1982, the Conduct Section would require the services of 65 additional employees or make heavy overtime payments to the existing staff. When this note was discussed by the Registrar in a meeting of the officers of the Examination Branch, some of them suggested that the only way to clear the arrears of work and hold examinations in time was to computerize some aspects of examination work. The Registrar held meetings with selected officers of the Examination Branch to discuss issues relating to computerization. He also held meetings with representatives of two computer firms who had been approaching the University persistently and were known to some officers.

In the middle of February 1982, the Registrar and a couple of officers visited some computer firms in New Delhi. On their return, they engaged in negotiations with the principals of the two computer firms regarding work, cost, programming, volume of work, etc. On February 26, 1982, the Registrar submitted a three-page note to the Vice Chancellor in which he mentioned that the cost of tabulation by computer would be less than the manual cost. He also said that mechanical tabulation would be quicker and cheaper as well as more efficient and neat. He requested the Vice Chancellor to approve a proposal to allot undergraduate examination work to the specified firms on the terms, conditions and rates negotiated by him. The Vice Chancellor approved the proposal on February 28, 1982 with the remarks that he had no doubt that computerization would be much better as the expeditious process of working the examination system which was in bad shape. He advised the Registrar and the Controller of Examinations to take every care while introducing the computerization process. Further negotiations with computer firms led to allotment of post-graduate examination work to two other firms, one of which was locally based.

The computer firms were assigned the task of preparing roll-lists, numerical returns, blank award lists, tabulation registers, list of successful and unsuccessful candidates, merit lists, mark-sheets, press release of results and statistical abstracts.

Naive Hopes Belied

The University authorities naively believed that, with the introduction of computerization of examination work, most of their problems would be taken care of. The computers would enable them to clear the arrears of work, expedite the whole examination process and enable them to declare results accurately and on schedule.

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Little did they realize that their hopes would be belied, the loss of an academic year become imminent and that the reputation of the University would touch rock-bottom level. The reasons for this become quite clear from the flaws in the policy process and the misconceptions harboured by the University authorities about computers.

**Misconceptions**

There is no doubt that the decision of the University authorities to go in for computerization was born out of a sincere and genuine desire to restore the academic calendar and uphold the reputation of the University. However, an analysis of the decision-making process reveals that the computerization decision was more a response to a desperate situation rather than a well-planned application. The timing coincided with a period when the administration of the University was in a state of disarray. Yet the expectations from the computer were so high and unrealistic that when 1982 examination results were declared months behind schedule and full of errors, the blame was conveniently put on the computer and not on the personnel involved. It was left to two in-house committees and one external committee which made a detailed study of the 1982 examination fiasco to point out that it was the nature of the decision-making process and the internal malfunctioning of the University which were principally responsible for the disappointing outcome.

**Flaws in Policy Process**

Most of the functionaries involved in the decision were not sufficiently familiar with the functioning of computers. They had a vague understanding of the potential of computers but had virtually no exposure to them. In addition, the then Vice Chancellor and Registrar were relatively new to their jobs, and were not fully aware of the nuts and bolts of the manual examination process. It appears that in their desire to improve the working of the system, they relied on the advice of subordinate officers and advisers who led them to believe that computerization was the only solution in the given circumstances. To make matters worse, the University authorities either did not deem it proper or did not have sufficient time at their disposal to utilize the services of a consultant or expert to advise them on the mechanics of computerization.

**Prey to Salesmanship**

The University authorities were also influenced to a considerable extent by the high-pressure salesmanship of a few computer firms, which convinced them that once the work was allotted to them the University officials would be relieved of day to day headaches in supervision and monitoring of examination work. The University did not countercheck the claims of these firms, examine their antecedents, past performance and experience and their physical capacity to perform the tasks assigned to them in the given time schedule. No tenders or quotations were invited before allotting the computerization work to two 'outside' firms. This was a violation of financial rules and prevented a number of competent firms from bidding for the contract at competitive rates. It turned out that the firms which obtained the contract did not enjoy a good professional reputation, had no previous experience of doing examination work, did not possess the physical capacity to undertake the job in the available time and charged the University more than the market rates.

When the decision to allot computerization work to a few selected firms on the basis of negotiations became the subject of adverse criticism in the Press, the University administration was compelled to invite some other firms for negotiations and this led to the allotment of post-graduate examination work to other firms at lower rates. The Finance Officer, who was left out of the entire process, later estimated that the University was subjected to a loss of approximately Rs 400,000 due to the confusion. The computer system of one of the firms was too small to handle the allotted work, and, without consulting the University authorities, the firm had subcontracted part of the work to another firm located in Bombay.

One of the major drawbacks in the decision-making process was that the main stakeholders, who play a critical role in the success or failure of any new policy or reform—representatives of teachers, employees and students—were not taken into confidence. The university’s past record of unsuccessful examination reforms was, in large measure, a result of the non-cooperation and obstructionist tactics adopted by unions of teachers, employees and students. Due to their non-involvement, the unions did not understand the motives of the administration and viewed the changeover to computerization with mistrust, apprehension and resentment. When results were
not forthcoming they became vociferous and virulent critics of computerization. The Registrar and the Controller of Examinations made no attempt to explain the rationale of their decision to the officers and staff involved in examination work. A number of them believed in the Union propaganda that it was basically an indirect strategy to deprive them of well-deserved overtime payments.

Teachers who were responsible for tabulation and checking of results also viewed computerization with similar apprehensions. In their role as head examiners and co-examiners, they were not briefed about the methodology for entering marks in the computerized award-sheets. Principals of affiliated and constituent colleges had a major responsibility in getting application forms filled in the new format designed to facilitate computerization and to ensure that these reached the university office before the prescribed date. They were responsible for receiving computerized roll-lists, numerical returns, tabulated results and mark-sheets for distribution to staff and students. They were required to explain discrepancies or errors to 'agitated' students. Yet they were not taken into confidence.

**View of Computerization**

The view of the computerization process in 1982 was that the computer would do whatever the manual system was doing—faster, neater and better. Few in the University administration could conceive that computers had their own limitations and that an enormous amount of discipline is built into the computerization process. The lesson that the quality of information fed into the computer has a vital bearing on its output was learnt the hard way. The computer could not be expected to make up for human errors and delays and still meet impossible deadlines arbitrarily imposed on it. Formats developed after due care and considerable labour could not be chopped and changed at will without allowing the computer personnel time for programming the necessary changes. The practice of feeding batches of data in several instalments did not aid the computerization process either. It was rather difficult for the University authorities to comprehend that computers did make mistakes and that these could be rectified only by laborious manual checking.

**Computer’s Inflexibilities**

It was not also realized that a manual system can handle complex situations and exceptions along with routine whereas the handling of complex situations and exceptions on a computerized system required careful systems analysis and programming. Based on their long experience, the officers and staff of the University could make necessary adjustments to accommodate complexities/exceptions while working out results as a matter of routine. They presumed that having provided the basic inputs to the computer firms, their personnel would be able to programme the computers for catering to complex and exceptional cases. They did not appreciate that the changes made by the University in the examination schemes over the years made it extremely difficult for persons unfamiliar with the system to grasp these complexities quickly. The kind of complexities, beneath what appeared on the surface as a simple tabulation job, may be illustrated with these examples:

- the backlog scheme allowed LLB students to obtain their degrees in nine years instead of three, thereby a student could accumulate a number of backlog papers
- the University permitted each undergraduate student as many as six chances to clear compulsory papers. In fact, some students enrolled in post-graduate courses had not cleared their compulsory subjects
- the scheme for improvement of performance permitted a post-graduate candidate to appear in 50 per cent of the papers offered by him in his final M.A examination to enable him to improve his performance. The performance in these papers was only counted if it was better than his previous performance
- according to University rules, ex-students (those who had failed as regular students) were to be credited with marks obtained by them in the practical examination of the previous year, instead of repeating their practicals
- grace marks were awarded to students who failed to pass their final examination by a very narrow margin.

The computer personnel were not in a position to programme these complexities. It became evident
that computer programmers and analysts needed more assistance, guidance and cooperation than had been envisaged. This was not easy as the computer firms were situated at a considerable distance from the headquarters of the University. Consequently, a number of errors crept in which undermined the credibility of the entire process.

**Ineffective Management**

As stated earlier, the University administration was virtually in a shambles. This is best illustrated by the manner in which the work relating to despatch, receipt and checking of examination application forms was handled.

The date for receipt of application forms for appearing in 1982 examinations had been extended from October to December 1982 due to non-availability of printed forms. When the application forms were distributed to 200-odd affiliated colleges, they were accompanied by a specially designed format which was to be fed to the computer. Due to lack of supervision and guidance on the part of the college staff, several students did not fill in the application forms legibly or carefully. Consequently, the check list prepared by the computer on the basis of these forms had a large number of errors which took several days and considerable manual effort to correct. The colleges affiliated to the University were taking the liberty of sending application forms in several installments long after the last date for submission; often without the prescribed fees. The submission of application forms in such a haphazard manner also upset the schedule for computerization.

The deadline for the staff of the Examination Branch for checking forms were not strictly enforced. The computer firms expected to receive forms of all eligible candidates by the end of March, 1982. But their job was made extremely difficult by the continuous flow of application forms in batches through April and May. As a result, the computer had to produce many roll lists from time to time instead of one consolidated roll list for every class.

**'Fictitious' Roll Numbers**

Over the years, the University authorities had allowed themselves to be pressurized into accepting application forms directly from student leaders and acquaintances after the last date for submission of forms. Many candidates were allowed to appear in the examinations with the permission of centre Superintendents, who allotted them "fictitious" roll numbers. The University staff was, used" to this ad hoc manner of functioning and -was able to make necessary adjustments while working put the results. In the computer system, there was no scope for accommodating such students. Eligible students were assigned Roll Numbers and Centres were fixed by the computers at the very outset and there was virtually no scope for accommodating students who appeared in the examination at the last minute.

The University authorities were also wither liberal in granting permission to candidates for changing the optional subjects and even their examination centres. Late declaration of supplementary and re-evaluation results also led to changes in the eligibility of candidates! The Computer firms were not informed of these changes.

Naturally, several errors crept into the computerized results as illustrated:

- A student, registered to appear at Centre 'X' and who obtained last minute permission to appear at Centre 'Y' was marked absent
- A student of B A, who changed one of his optional subjects from History to Political Science, was awarded zero marks in History, ignoring his appearance in Political Science.

**Compounding the Problems**

To make up for the delay in holding exams, the University decided to send answer-books to examiners directly from Examination Centres, instead of from the University. Also, examiners were directed to send the award-sheets directly to the computer firms. Both these changes were ill-advised. Due to delays in appointment of Examiners, transportation bottlenecks, and carelessness on the part of several examiners, the assessment of answer-books took more time than was anticipated. As award-sheets were sent directly to computer firms the University was not able to check them, even on a random basis. Under pressure to tabulate results quickly, the computer firms accepted the award-lists as they were and the errors were compounded.

**Failure of Computerization**

There was complete confusion and chaos when the
examination results were declared during the period September to November 1982. Not only had results been delayed, they were full of errors. The computer confounded the University authorities by declaring that in many cases, it was "unable to work out results." This was either because the information fed to the computer was incomplete or it was not in accordance with the formats agreed upon. Since the computer firms were functioning outside Jaipur, a good rapport could not be established for clearing misunderstandings and bottlenecks. As delays took place, the University mounted pressure on the computer firms through frequent long distance calls, convening of urgent meetings and special messengers. Apart from the enormous cost involved, matters became worse as the relationship between University officials and computer personnel were strained.

The University was on the brink of losing an academic year and there was public outcry against the "computerization mess." In disgust and desperation, the Registrar quit his job. At the request of the Vice Chancellor, the State Government agreed to depute a specially selected officer from the Indian Administrative Service as Registrar with the specific purpose of restoring the academic calendar and streamlining the administration.

It was a Herculean task for me to clear the arrears, to restore confidence of the University and the community in computers and to work out a successful strategy for computerization in 1983 and thereafter. The highlights of the experience in the next three years follow.

**Defence of Computerization**

The foremost task was to convince the community that the disastrous experience of 1982 was the outcome of a combination of factors most of which were not of the computer's making. The employees' strikes, unfamiliarity with the working of computers, initial resistance to change and the inadequate time available for the switchover were projected as the major causes of failure. A large share of the blame was also assigned to the unsatisfactory and unreliable performance of the computer firms.

The following arguments were advanced in support of computerization:

- the successful use of computers by other universities and the Board of Secondary Examinations, Rajasthan
- the speed, accuracy and neatness of computer work
- relief to the staff from the drudgery of allotting roll numbers and from the onerous responsibility of making and checking hundreds of thousands of entries
- savings on paper, printing, binding, and envelopes for despatching question papers, and overtime payments.

University officials took great pains to explain the advantages of computerization to the University bodies, the enquiry committees, the Unions and to influential individuals within and outside the University community. Efforts were made to convince the critics to view the 1982 experience as a period of trial in very adverse circumstances. It was argued that it would be better to give the University administration another chance instead of throwing out the baby with the bath-water. The services of 'sympathetic' teachers and officers were utilized. The Syndicate and the Finance Committees finally agreed to give computerization one more try for the 1983 examinations.

**Remedies**

The University took the following remedial action in 1983 and thereafter:

- examination application forms were printed by the University press during the summer vacations and despatched to the colleges on the re-opening of the University in July
- the Principals were given detailed instructions on how the forms were to be filled and returned to the University. An illustrative list of errors committed in the previous year was circulated
- the University set up a monitoring and review cell to ensure the timely receipt and checking of application forms
- after deliberations with the concerned staff, deadlines for checking forms for each class were prescribed
- mutually acceptable dates were fixed for completion of each stage of the work by the University and the computer firms. The preparation and implementation of these schedules involved detailed micro-level planning, extensive coordination and intensive monitoring by the Registrar and other senior officers
• as far as possible, the University authorities did not accept any application for last minute changes of optional subjects or centres. If a few changes had to be made due to unavoidable circumstances, the computer firms were immediately informed
• the practice of Centre Superintendents permitting students to appear in the examinations with "fictitious" roll numbers was done away with
• the experiment of sending answer books directly to examiners and award-sheets directly to the computer firms was abandoned.

Results: 1983-86
By 1985, the academic calendar of the University of Rajasthan, Jaipur had been completely regularized. Table 1 shows the reduction in the time taken in declaration of results since 1982. Though other factors like the central evaluation of answer-books and the streamlining of the administrative system made a major contribution to this success, the role of computerization was critical. Encouraged by its experience, the University is seriously considering the computerization of personnel records, payrolls, and inventories.

Table 1: Time Taken for Declaring Results

<table>
<thead>
<tr>
<th>Examination</th>
<th>Days from the date of last paper</th>
<th>Manual</th>
<th>Computerized</th>
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<tbody>
<tr>
<td>Pre-University Arts</td>
<td>85</td>
<td>98</td>
<td>35</td>
</tr>
<tr>
<td>1st Year Arts</td>
<td>72</td>
<td>109</td>
<td>42</td>
</tr>
<tr>
<td>2nd Year Arts</td>
<td>76</td>
<td>116</td>
<td>45</td>
</tr>
<tr>
<td>3rd Year Arts</td>
<td>57</td>
<td>107</td>
<td>32</td>
</tr>
<tr>
<td>Pre-University Science</td>
<td>54</td>
<td>68</td>
<td>33</td>
</tr>
<tr>
<td>1st Year Science</td>
<td>30</td>
<td>65</td>
<td>30</td>
</tr>
<tr>
<td>2nd Year Science</td>
<td>71</td>
<td>90</td>
<td>21</td>
</tr>
<tr>
<td>3rd Year Science</td>
<td>40</td>
<td>72</td>
<td>14</td>
</tr>
<tr>
<td>Pre-University Commerce</td>
<td>83</td>
<td>116</td>
<td>40</td>
</tr>
<tr>
<td>1st Year Commerce</td>
<td>71</td>
<td>103</td>
<td>27</td>
</tr>
<tr>
<td>2nd Year Commerce</td>
<td>79</td>
<td>100</td>
<td>28</td>
</tr>
<tr>
<td>3rd Year Commerce</td>
<td>57</td>
<td>110</td>
<td>24</td>
</tr>
</tbody>
</table>

The validity of the cost saving arguments can be seen from the expenditure per student in the manual and computerized systems of examinations shown in Table 2. By 1985, computerization had reduced the per capita cost of conducting examinations to half the manual cost in 1981.

Table 2: Cost of Processing Examination Work

<table>
<thead>
<tr>
<th>Year</th>
<th>Manual</th>
<th>Computerized</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td>Under-grad</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(Main)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1982</td>
<td>5 to 5.27</td>
<td>3.49 to</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3.50</td>
</tr>
<tr>
<td>1983</td>
<td>do</td>
<td>2.78 to</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.84</td>
</tr>
<tr>
<td>1984</td>
<td>do</td>
<td>2.67 to</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.75</td>
</tr>
<tr>
<td>1985</td>
<td>do</td>
<td>2.47 to</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.51</td>
</tr>
</tbody>
</table>

* plus Rs 10,000 for software.

Administrative Convenience
Computerization was also administratively convenient. Handling of registers became easier. Voluminous hard-bound tabulation registers containing entries in the indifferent handwriting of hundreds of employees were replaced by convenient and neat computer records. The output of the computer was also free from overwritings and crossings out thereby making tampering of records far more difficult.

The computer was able to produce a variety of data and statistics required by the University from time to time for preparation of reports and submission of information to University bodies, the State Government and the Legislature.

Apart from early release of results, students did not have to wait weeks for their mark-sheets. They were issued on the day the results were declared. The students came to realize that computerization made them less dependent on the whims and fancies of numerous University clerks.

Good Rapport
Both the computer firms which had been hired in 1983 continued to render satisfactory services up to
1986. Over the years, an almost perfect rapport and understanding developed between the university authorities and the computer firms and between the computer firms themselves. The University administration ensured prompt payments to computer firms in accordance with the terms and conditions of the contract. An illustration of the mutual cooperation between the two is provided by the fact that the Registrar approached the State Electricity Board to ensure uninterrupted supply of electricity to the computer firms during peak periods of work. The computer firms helped each other to maintain schedules in case either’s computer went 'down' during critical stages of work.

The streamlining of the internal administration of the University resulted in the timely feeding of correct inputs to the computer. Many refinements were made in the computerization process. As the identity of the computer firms became widely known, extra precautions were taken for safety and secrecy of the records.

Today, no one can visualize a return to the manual system. The University of Rajasthan’s example is being held up as a model for other universities to emulate.

**Comparison of the Two Approaches**

A comparison of the two approaches to computerization of examination results—one in 1982 and the other between 1983 and 1985—is made in Table 3 at the end of this article. The approach in 1982 can be summarized as ad hoc, and the approach from 1983 onwards as systematic and well-planned.

**Recommendations**

Based on my experience of computerization in the University of Rajasthan, I would make the following recommendations for computerization of large data systems:

- the timing for introduction of a major innovation like computerization of examination results should not coincide with a period of turmoil, uncertainty and administrative disarray
- a general understanding of the benefits of computerization and a desire to bring about change are not sufficient. The ground has to be prepared well in advance with the aid and advice of experts. There is no substitute for a thorough systems analysis with particular emphasis on identification of exceptions from the routine
  - the active involvement of officers and employees is a pre-condition for computerization. Their psychological apprehensions should be viewed sympathetically. They should be given a fair and adequate opportunity to fully understand the implications of the change and to come to terms with it
  - in purchasing or hiring computers, the organization should not be unduly influenced by the aggressive salesmanship of computer firms. Experience and antecedents, capacity and track record of bidding firms should be thoroughly screened before awarding a contract. Contracts should be worded carefully and scrutinized by legal and computer experts
  - the organization should be willing to accept the discipline imposed by computers. Instructions relating to computer work should be precise and unambiguous. Responsibility for adhering to deadlines for submission of information and feeding of inputs ought to be specially assigned. Last minute changes should be avoided
  - it would be useful to bear in mind that computers cannot make up for human errors; in fact, they complicate and compound them
  - policy or procedural changes, necessary for switchover to computerization, should not be postponed or avoided
  - last but not the least, the decision to go in for computerization of large data systems must enjoy the support and confidence of the entire organization.

The experience of the University of Rajasthan illustrates the hazards of an ad hoc trial and error approach towards computer applications. No University can afford to play havoc with the careers of lakhs of students by making them guinea-pigs in an experiment which it is not fully and adequately prepared to undertake.
### Table 3: A Comparison of Two Approaches to Computerization

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>1) Context for introduction/continuation</td>
<td>Ad hoc response to desperate situation, administrative system in disarray, period of turmoil and uncertainty</td>
<td>Decision to continue with computerization taken after careful deliberations and consultations</td>
</tr>
<tr>
<td>2) Prior analysis of systems</td>
<td>Done perfunctorily, mostly left to computer firms who had no experience</td>
<td>Indepth systems analysis and programming on the advice of computer experts and experience</td>
</tr>
<tr>
<td>3) Involvement of staff</td>
<td>Only a few officers and clerical staff involved</td>
<td>Involvement, participation and coordination of all units and important functionaries: computer experts and firms regularly consulted</td>
</tr>
<tr>
<td>4) Orientation of staff for switch over</td>
<td>None</td>
<td>Through regular meetings orientation sessions and on the job training in collaboration with firms</td>
</tr>
<tr>
<td>5) Creating an environment for change</td>
<td>University bodies not consulted; Unions ignored; State Government not kept in picture; press not informed</td>
<td>Consultation with University bodies, Unions taken into confidence; State Government kept abreast of developments, and press briefed</td>
</tr>
<tr>
<td>6) Award of work to computer firms</td>
<td>To outside firms: negotiations conducted by Registrar and the Controller of Examinations, limited knowledge about antecedents and capacity of firms; influenced by aggressive salesmanship of computer firms and conditions left vague; work allotted in an ad hoc manner</td>
<td>To local firms through open tenders on the advice of computer experts, antecedents, experience and capacity of successful bidders verified in advance: terms and conditions carefully drafted and legally vetted; reputation and performance cross-checked with other users; work allotted as per capacity and expertise of firms</td>
</tr>
<tr>
<td>7) Interaction with computer firms</td>
<td>Limited interaction, duplication of responsibilities among staff of Examination Branch; no time schedules; formats arbitrarily prescribed or left to computer firms</td>
<td>Continuous interaction between University and computer personnel, clear responsibilities assigned; deadlines set for University and computer firms; formats designed after in-house discussions and consultation with computer firms</td>
</tr>
<tr>
<td>8) Payments to computer firms and working relationship with them</td>
<td>Payments delayed, lack of communication; relationships strained</td>
<td>Prompt payment, close interaction; excellent working relationship</td>
</tr>
</tbody>
</table>