SUMMARY OF SESSION 3
HOW SHOULD ACCELERATOR OPERATIONS BE ORGANIZED?

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1. INTRODUCTION

The underlying structure and organization of a group strongly influences its effectiveness and efficiency. An operations group may develop a 'persistence of form' that prevents it from responding to changes in responsibilities and technology. Even if a group has been in existence for a long time, it is a good idea to re-evaluate its structure periodically. An organization can possess an aesthetic quality related to how simple and transparent its functions appear to users and other outsiders. Information and tasks should flow freely without undue impedance. In this session we examined the issue of group design from a variety of perspectives including both large and small labs, commercial operations and that of an 'expert' consultant.

2. ENGINEERING PROCESS MONITORING FOR CONTROL ROOM OPERATION

Mario Batz (CERN) told us how an existing operations group at a large established accelerator lab could change their conduct of operation by looking at their organization from a different perspective. The Technical Control Room operations group monitors and controls the conventional facilities, such as cooling water, vacuum equipment, fire alarms, cryogenics, and electric power, for the entire CERN site. The control room was characterized as a high stress environment, with many system alarms and user requests coming in simultaneously, especially during service outages. The group turnover rate was as high as 20% per year.

By first agreeing on the process objective (i.e. to maximize up time for the CERN Accelerators), and then identifying the key processes, systems and resources needed to reach that objective, they can organize their group to more effectively reach their goal. They can make decisions on how they will respond to crises, and conduct operations with this structure as a guide. This leads to decisions for Alarm and Status Engineering, Procedures for Crisis Management, and Operator Training, to name but a few.

This structured approach to the design of an operations group can be generalized to future projects. This method of organizing TCR operations with a production goal in mind has many parallels with commercial cyclotron operation, as we learned in the next talk.

3. THE ORGANIZATIONAL STRUCTURE OF OPERATIONS GROUPS IN A COMMERCIAL ACCELERATOR FACILITY

Nigel Stevenson (Theragenics Corporation) talked about some differences between experimental and commercial facilities:

Commercial	Laboratory
Product focused	R & D focused
Industrial commercially available equipment	Specialized equipment (home built)
Non-academic staff	Academic staff
Pragmatic attitude	Perfectionism
Long term stable mode of operation	Dynamic / changing modes of operation
'For Profit'	Government funded
Motivation: quantity & 'Status-Quo'	Motivation: quality & new challenges

It is also generally true that operations group members are of two general types:

1) Jack of all trades. Typically found in smaller linear organizations.

2) Specialized roles. Often found in extended or parallel organizations.

Commercial operations usually fall into the first category, but as they grow they may evolve into the second type. The (inter)national labs often operate in the second mode. Each type of organization can benefit from examining the strengths of the other.

4. COMPLEXITY MANAGEMENT THROUGH INFORMATION TECHNOLOGY AT THE ALS

The needs of the ALS users drives the requirement for a highly stable orbit. Jan Pusina described the hardware and software architecture that allows the ALS to fulfill these requirements. Jan also described the operations group structure that has evolved at the ALS. One of the features of the way they do business is the adoption of a fixed owl shift crew. This point generated a few comments at the end of this talk. While claiming the advantage of having a stable staff, Jan concedes that the owl shift crew tends to get out of touch. The ALS uses the web to access standard procedures and training.

5. BUILDING AN OPERATIONS GROUP

Pierre Bricault gave us a look at how an accelerator operations organization to run the new ISAC Radioactive Ion Beam Facility at TRIUMF was built. ISAC was faced with a new accelerator at the end of its commissioning phase, ready for physics users. The first question was: Who can operate it? One possible answer was to have some existing group take over. Perhaps the users could run it themselves, like ISOLDE at CERN. For several reasons this was not acceptable. Another possibility was the existing Cyclotron Operations group at TRIUMF. But this, too, was not acceptable. So ISAC began the task of building its own small group. In answer to the question, ‘At minimum what do we need?’

1) A Group Leader, to set policy and goals, and to interact with management and the experimenters.

2) A Coordinator, to handle training and documentation.

3) Operators

To fill the operator positions, ISAC looked for people with characteristics such as curiosity, creativity, insight, perspective, common sense, consistency, good work habits, ability to learn from mistakes, and in general, someone with a diversity of skills.

Now, what type of standards would be set for training the operators? ISAC was faced with recent decisions by the Canadian government and the Nuclear Safety Commission which mandated that nuclear facility standards be applied to particle accelerators. This forced ISAC to design and implement a formal training program. The mandated ‘Systems Approach to Training’ includes:

- Training Analysis
- Evaluation of the program
- Training Design
- Conduct of Training & Evaluation
- Validation of Training

6. STRESS AND SHIFT WORK

Mina Michal presented a talk about the intense biological stress of working shifts. Understanding the physiological basis of such stress can help us develop coping strategies. These stresses and strategies represent some important input into the organizational design process. Those of us that attended WAO'96 may remember broad similarity in the advice offered by Ms. Michal and the earlier workshop's talk on sleep deprivation. The experts seem to agree on the nature of the problems and the best ways to minimize them.

7. SESSION CONCLUSIONS

Even though the title question of this session may not be easily answered, it seems that we should periodically ask it. The optimal structure for each group depends heavily on that group's size, resources & goals. Some of the newer factors to consider may include the desire to implement on-line logbooks & pressure to adopt systematic and documented training programs.

We hope that this session, especially the hallway and dinner conversations that may have been sparked inspire you to re-examine how your group is organized.

ENGINEERING PROCESS MONITORING FOR CONTROL ROOM OPERATION

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Abstract
A major challenge in process operation is to reduce costs and increase system efficiency whereas the complexity of automated process engineering, control and monitoring systems increases continuously. To cope with this challenge the design, implementation and operation of process monitoring systems for control room operation have to be treated as an ensemble. This is only possible if the engineering of the monitoring information is focused on the production objective, and is lead in close collaboration with control room teams, exploitation personnel and process specialists. In this paper some principles for the engineering of monitoring information for control room operation are developed using the example of the exploitation of a particle accelerator at the European Laboratory for Nuclear Research (CERN).

1. INTRODUCTION

Many similarities exist between CERN and production industries concerning the processes, process control and control room operation. CERN's main production objective is related to particle beams and luminosity, for which various traditional industrial processes are necessary, such as water-cooling and electrical systems. Still today production processes cannot be automated completely. The remote monitoring from a control room is an essential element of the total effectiveness in meeting the production objective. The process information that is available for control room operators determines, amongst other things, the correctness and speed of their decisions and actions.

In preparation for the LHC operation, the SPS/LHC accelerator control room (PCR) and the Technical Control Room (TCR) have launched a project to study the recovery of the Super Proton Synchrotron (SPS) after major system breakdowns. The activities of both the control rooms shall be focused on the main production objective. The documentation of operation activities, as well as the specification of process monitoring tools, and the needs of operator training will be established to minimise the down time of the SPS.

The monitoring information presented to the control room operators has to be defined through close collaboration between control room teams, exploitation personnel and process specialists. Although the basic principles and requirements are identical for many processes, a method shall be available to rationalise the engineering of the monitoring information that will be applicable to the future LHC operation and other CERN accelerators.

2. SITUATION TODAY

During the engineering of the TCR monitoring information the particle beam production has not been considered systematically and the design approach has been different for different processes. In the same way, the monitoring of the technical infrastructure has not sufficiently influenced the monitoring information of the PCR [1].

In the PCR and the TCR the workload, knowledge and background of the operators are different and the operation teams are hosted in different control rooms. Even more importantly the work objectives after major control room incidents are not identical:

- **For the TCR:** the restart of the technical infrastructure for the whole laboratory where the accelerators do not have exclusive priority
- **For the PCR:** the restart of the accelerator equipment and finally the particle beam

The monitoring of the technical infrastructure of CERN's accelerators by the TCR is based on alarm list displays, synoptic diagrams and trend curves of process values. The processes under control are:

- electrical distribution and supply,
- ventilation and air-conditioning,
- water distribution and cooling, demineralised water production and distribution,
- beam vacuum and compressed air,
- monitoring and control system infrastructure,
- fire and gas detection equipment,
- communication equipment, such as telephones and intercom.

The state of the main process elements (pumps, valves, switches, analogue values etc.) are represented on synoptic diagrams for each individual system. From a general process overview the operator can navigate to the details of sub-processes. Alarms are transmitted in parallel to the synoptic diagrams and to an alarm list display, where the operator has an overview of all the alarms active in any of the monitored systems. A simple indication of the consumers on the accelerator site exists on the synoptic diagrams.

The monitoring applications for each process are independent, so that navigation between synoptic diagrams of dependent processes is difficult. The alarm list display does not show group alarms of the same or different processes together, nor does it apply any filter criteria. Thus, the control room operators need a lot of background information to exploit the monitoring information and to quickly assess failures. Furthermore, complementary information has to be looked up in operation instructions, which are not part of the monitoring system.

The TCR and the PCR share the same data logging tools and the PCR uses some of the TCR process synoptic diagrams. However, the operators do not have enough background information to efficiently use the monitoring tools that are technically available in both the control rooms.

3. MONITORING INFORMATION ENGINEERING

The engineering of the monitoring information shall be based on a proper identification of the production objective, the production processes and sub-processes, see figure 1.

To meet the main production objective, the different processes of the main systems, such as electricity, cooling, vacuum, have to be identified. The processes will consist of sub-processes, such as cooling towers, water demineralisation, which in turn can be split into operations, such as pressure control, temperature control. Any of these elements has time dependencies and dependencies with other sub-processes or operations. The combination of those dependencies determines the critical paths for any restart operation [2].

All the information has to be available for the control room operators in the form of visualisation diagrams for the critical paths, process diagrams and alarm list displays; although not to forget the operation instruction, see figure 2.

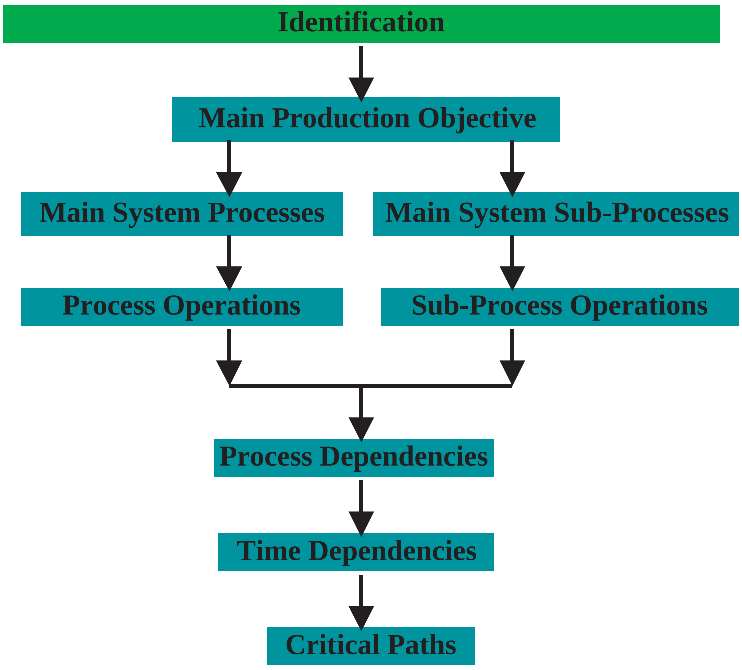

Fig. 1: Monitoring Information Identification Process

In order to have a complete picture of all the influences and constraints, the exploitation personnel and process specialists have to contribute their know-how during the engineering phase [3]. This exercise has to be done for different phases in the production process such as start-up, process studies, production optimisation, physics, maintenance (stand-by) etc.

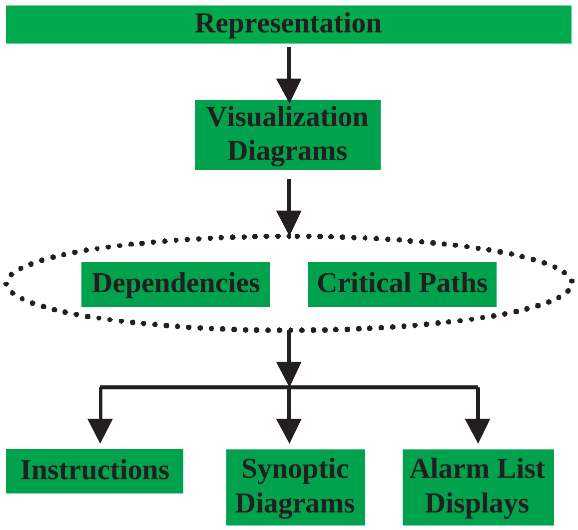

Fig. 2: Representation of Monitoring Information

4. RECOMMENDATIONS

The work objectives of the PCR and the TCR after a major incident have to be identical: it has to exclusively serve the main production objective. Major incidents have to be treated from the managerial point of view as a crisis. Thus, the information concerning faults and failures has to be as transparent as possible for both the control rooms, as far as the main production process is concerned. Details of each of the processes have still to be adapted to the particular needs of each control room. The engineering of the monitoring information has to be optimised for the restart of the main production process and not for the restart of each individual system process.

The control room operators have to be enabled to find the best restart strategy based on process dependencies, process functions and nominal operation values. The following information shall be available, so that decisions and actions can be taken rapidly:

- availability of the main production process and the main system processes,
- state of the critical paths and the dependencies,
- unavailability of process equipment and causes (fault states),
- actions to be taken to re-establish the availability of the processes,
- detailed information on the process equipment to verify the correctness and coherence of process information, to verify the correctness of the standard restart procedure and to establish alternative procedures, if necessary,
- trend information of process operations that are part of the critical paths,
- nominal process values and process limitations.

Depending on the type of information, the representation method and the degree of availability of this information can be determined. As far as possible this information shall be delivered 'in real-time' via a computerised monitoring system. Navigation to the information shall be orientated towards the control room operator's tasks. Navigation between trend displays, synoptic diagrams, visualisation diagrams and alarm lists shall thus be seamless.

Furthermore, the distribution of control actions between an automatic system and the control room operators has to be documented in a transparent way, especially when several control rooms are in charge of different processes, the faults, failures and the advancement of the restart of processes will be transparent. Field operators as well as crisis teams have to be kept up to date in the best possible way too.

5. CONCLUSION

The key to the realisation of process monitoring by control room operators is the focus of monitoring information engineering to the main production objective. The proper analysis of the processes and activities needed to keep the availability of the production, leads to a task oriented design of the monitoring tools. In addition, increasing the clarity of information that is exploitable, without too much background information, is important to improve communication and information flow after major breakdowns. The management of such crises will profit from this and the reduction of down time becomes easier.

This paper has shown the major principles that shall be applied using the example of the SPS exploitation by the TCR and PCR. However, this analysis is still on-going. The final results will be published later and shall be applied to the engineering of monitoring information and systems for the LHC.

References

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THE ORGANISATIONAL STRUCTURE OF OPERATIONS GROUPS IN A COMMERCIAL ACCELERATOR FACILITY

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Abstract
The number and the complexity of commercial accelerator facilities have grown dramatically over the past few decades. The challenges of operating such facilities within a business environment often include demands on efficiency, flexibility and meeting stringent product delivery schedules. The organisation of an accelerator (usually cyclotron) operations group to handle these demands is somewhat different from that typically set up in research accelerator laboratories. However, similarities are present and much can be learned from past examples of successes and failures at commercial accelerator facilities. Research facilities are themselves experiencing changes towards increasing resource demands, restrictive budgeting scenarios, and reduced staffing levels. As this change occurs, they may have to move into an operations mode that is indeed closer to that typically seen at commercial facilities. This talk will look at staffing, maintenance, development and training, radiation dose issues, shift-work and other aspects of running a commercial accelerator facility.

1. COMMERCIAL ACCELERATOR FACILITIES

Commercial accelerator facilities include radioisotope production cyclotrons, LINACS for therapy, commercial positron emission tomography units, elemental analysis technology, etc. In contrast, experimental (national, university, etc.) laboratory accelerators tend to be more unique in nature. The philosophy and mode of operation of these two types of facilities is exemplified in Table 1. Having said this, it must be recognised that factors such as reduced government budgeting are, by necessity, bringing the operational modes of many accelerator laboratories increasingly into the ‘commercial’ realm.

Table 1: Typical characteristics of commercial and laboratory accelerator facilities

Commercial	Laboratory
‘For Profit’	Government Funded
Product Focused	R. & D. Focused
Industrial/Commercially Available Equipment	Specialised Equipment (Home-Built)
Non-Academics	Academic Staff
Pragmatic Attitude	Perfectionism
Long-Term/Stable Mode of Operation	Dynamic/Changing Modes of Operation
Motivation:	Motivation:
• Quantity	• Quality
• Status-Quo’	• New Challenges

When setting up or evaluating a commercial accelerator facility some items to consider are:

- Increase/Retain/Reduce Staff Levels?
- Operations only? Development?

- Complexity of Operations -
  - (medical) LINAC (<1 Operator/Machine)
  - CYCLOTRON (> 1 Operator/Machine)
- Size of Operations (# Accelerators)

We will now explore one of the most common examples of a commercial accelerator facility – radioisotope production cyclotrons.

2. ORGANISING COMMERCIAL CYCLOTRON FACILITIES

Two modes of organising the operations staff are commonly employed:

1. **Jack-Of-All-Trades':**

   Staff perform all activities

   Suitable for smaller facilities

   Multi-skilled individuals

   Flexible operations

   Potential for burnout?

2. **Specialised Roles:**

   Staff perform specialised functions

   Suitable for larger facilities

   Specialists

   Not as flexible (needs cross-training)

   Less stressful

The first mode of operation in which all employees perform all of the tasks is often run as a linear organisation as depicted in Figure 1.

Larger cyclotron facilities more often move into a parallel mode of operation in which cyclotron operation and cyclotron support functions are separated as specialised tasks, as shown in Figure 2. If the facility has R.&D. and/or other project responsibilities then this organisation may need to be extended, typically as displayed in Figure 3.

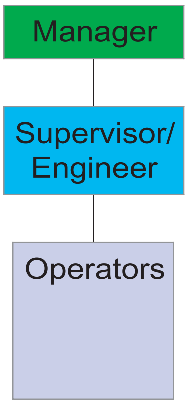

Fig. 1: Linear organisation

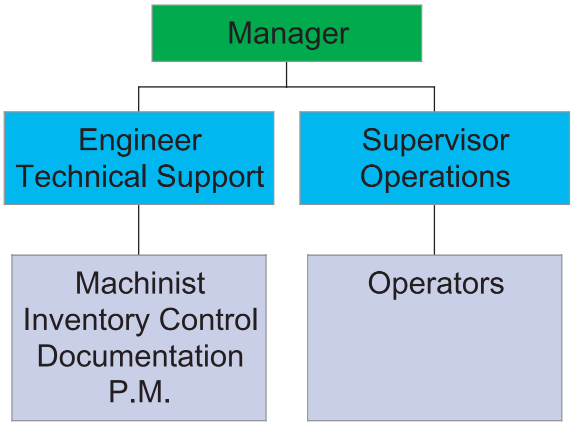

Fig. 2: Parallel organisation

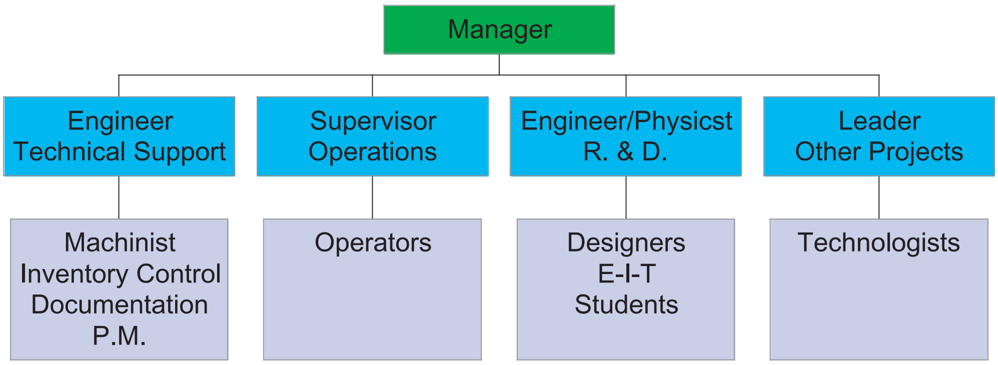

Fig. 3: Extended organisation

3. OPERATING COMMERCIAL CYCLOTRON FACILITIES

Typical characteristics and challenges for the two main groups within a parallel organisation are:

1. **Operations:**

   E-M Technologists

   Trouble-Shooting Skills

   Production Scheduling

   Shifts?

   Radiation/Hazardous Environment?

2. **Technical Support:**

   E-M Technologists/Engineers

   Trouble-Shooting Skills

   Technical Planning (Preventative Maintenance)

   Radiation/Hazardous Environment?

   In-House Inventory Control, Document Control, Machining, etc.

One of the major disadvantages that typically comes with larger facilities and operating in a parallel mode (specialised assignments) is achieving comprehensive (‘round-the-clock’) expertise for trouble-shooting and routine maintenance activities. This can be handled by setting up a comprehensive listing of specific assignments, showing primary and back-up responsibilities, as typified in Table 2.

Table 2: A method for task and skill assignments

Task	**Primary**	**Secondary**	**Tertiary**
Ion Source Replacement	Operator A	Technologist 2	Operator B
Mech. Pumps - P.M.	Technologist 1	Operator A	Technologist 3
Target System - Retrieval	Operator B	Technologist 3	Technologist 1
Nucl. Vent.- Filter Change	Technologist 2	Technologist 4	Operator C
……….	…………	…………	…………
……….	…………	…………	…………

4. OPERATIONS AND STAFFING ISSUES

With increasing demands on cyclotron staff, alternative opportunities, limited budgets, etc. it becomes imperative that we make these facilities challenging, enjoyable, etc. Some final points to consider when setting up and running commercial accelerator facilities are:

- Allocation of Staff According to Skills
- Provide Ongoing Education – Technical and Management (if appropriate)
- Personnel Development Planning
- Opportunities to Change Career Paths
- Limited Autonomy
- Make Work Enjoyable
- Provide Employment Security

Running commercial accelerator facilities has challenges and rewards that are somewhat different from those experienced within a laboratory environment. However, the skills and mechanisms employed to successfully operate such an organisation has many aspects that are also transferable into the laboratory realm. This is especially so with increasing budgetary pressures and the emphasis now being placed on laboratories for researching industrial applications and participating in the technology transfer process. By necessity, laboratories are evolving and adapting to these circumstances and the mechanisms described in this presentation are also increasingly applicable to this environment.

COMPLEXITY MANAGEMENT THROUGH INFORMATION TECHNOLOGY AT ALS

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Abstract
This paper addresses management of the Advanced Light Source accelerator systems through computer hardware and software. It also examines the overall design of the accelerator Operations Group, including training and safety. Accelerator physics at the ALS moves toward control of ever-shrinking spatial and time dimensionality, driven by the needs of end-station users (atomic, surface, biological, and nano scientists, to name a few). For smooth operations, data accessibility and processing must be fast, flexible and highly organized. Fine control and monitoring of beam and equipment parameters necessitates systems whose complexity is out of proportion to previously existing systems. With the addition of functions such as longitudinal and transverse feedback systems and higher harmonic cavities, the orbit must be stable on the scale of a few micrometers. To be discussed are design of control room computer applications and networks, and automated operational procedures to cope with the needs cited above.

1. THE MACHINE

The Advanced Light Source is a third generation synchrotron accelerator, which delivers high brightness radiation in the energy range of infrared to soft X-rays, to approximately 27 beamlines. The accelerator complex consists of an electron gun (120 KeV), linac (50 MeV), booster synchrotron ring (1.5 GeV), and a storage ring which ramps down to 1.3 GeV or up to 1.9 GeV. A typical run cycle consists in filling and ramping (15 min.), and providing light to users (six hours). The storage ring has a capacity for 328 buckets, with 276 typically filled, leaving a dark space for users doing time-of flight experiments. In some cases a single high intensity bunch is injected in the dark space (a ‘spike’ or ‘camshaft’) to provide a trigger for teams looking at time-dependent x-ray phenomena, either with solids or gases (beamline 5.3.1). Every six months, for two weeks the machine is run in a two-bunch mode.

The storage ring lattice has the capability of three bend magnet ports in each of the 12 sectors, and an insertion device in ten of the straight sections, the other two straight sections being reserved for injection devices and RF cavities. In actuality we have two bend magnet ports in most of the sectors, and 7 insertion device beamlines. Many beamlines have multiple branchlines.

2. SYNCHROTRON RADIATION AVAILABLE TO USERS

Users’ light energy is in the range of 0.5 out to 12.4 KeV photons, in 30-pS bunches. The radiation is used for a variety of scientific disciplines, including atomic physics, biology (protein crystallography), chemical dynamics, materials and surface science, and X-ray microscopy.

3. ALS OPERATIONS

There are typically two operators and two electronics maintenance technicians present on each shift. Operators may serve as beamline coordinators when not actually running the machine, especially on off shifts. The technicians can look forward to career growth as electronics coordinators, while operators may move to associate scientists on beamlines. The ALS has a strong training program, consisting of a dedicated Procedure Center, with online access to all ALS procedures. The maintenance schedule consists typically of 5 shifts per month dedicated to maintenance and installation, with longer periods for major installations. The ALS uses operators actively, e.g., for troubleshooting, rather than simply to make adjustments. Operators are seen on the floor as well as in the control room, in a directorial capacity.

Day-to-day safety issues are met by operations coordinators and beamline scientists. On off shifts the emphasis for safety is on use of operators and electronics maintenance personnel. There are periodic Safety Circle meetings coordinated by an industrial hygienist, who reports to Environmental Safety and Health.

The owl shift crew schedule is fixed, with respect to personnel, the other members of the crew rotating between day and swing shift. We find this yields a stable operations staff with relatively low turnover. On the other hand, keeping one crew constantly on owl shift tends to cause them to lose touch with machine developments. However, the increased stability it lends to operations outweighs any disadvantages, as proven in 30 years of practice at the Bevatron and ALS.

4. PROGRESS 1990-2001

There were several significant events that served as milestones in the development of the ALS. Because of the severity of the challenges they posed, the administrative, engineering, and scientific strengths necessary in overcoming them provided opportunities for growth. First there was the commissioning of the ALS itself. During construction, the various groups (electronics, mechanical, etc.) worked well as independent groups, but when operation began it was discovered that they needed much more interfacing among one another than before. In a sense, group building had to take place.

Another significant historic event was damage caused to one of the flexbands, a series of thin metal strips designed to provide a smooth RF surface inside the vacuum chamber. The event was precipitated by the use of an unusual fill pattern with many single bunches, causing fatal heating due to the peak beam power. The machine was down 17 days while the physics and operations groups struggled to find the cause of the damage. Finally, an operator found a way of threading beam around the obstacle, thereby identifying its location and allowing for a fix.

The Birgeneau report, a DOE mandated review of four synchrotron facilities, provided the incentive for rearrangement of the coordination staff, in which beamline coordinators were moved functionally closer to operators, and the creation of a new LBNL division, the ALS Division. The latter process reduced the administrative distance between the lab director and the ALS Facility.

In the spring of 2001 we look forward to the installation of three super bend magnets, and to their attendant cryogenic issues.

5. DEVELOPMENT OF INFORMATION TECHNOLOGY AROUND MACHINE ISSUES

The ALS controls system was designed around the end of the 80’s, in preparation for the start of ALS commissioning. Some early software tools still in use are CTLPlay, Toolbook and DBChan, the latter being a ‘primitive’ Windows application that lists the entire machine database, through filtered searches. These programs are all still in use, although the first two are slated for replacement. In fact, the control system is currently involved in an upgrade, in order to address these and other issues, including a system capable of making kilohertz readouts of BPMs available in the control room.

A long-standing problem with storage ring beam is the unevenness of the amount of charge bucket-to- bucket. This unevenness contributes to beam instabilities and loss of lifetime, and is caused, in part, by unequal intensities of gun bunches injected into the booster ring, probably due in turn to uneven energy in the linac from pulse to pulse. I am currently developing a program for fill optimization to address this issue (see below).

In 1994 the first undulator was installed, and six more have since followed, necessitating feedforward routines for precise orbital correction. In 1997 the longitudinal and transverse feedback systems were added. Together, they reduce the transverse beam size from ~300 to ~60 microns. After an extensive period of commissioning by SLAC and ALS personnel, these programs have continued to be developed at the ALS. Until recently they have been among of the most frequent causes of downtime.

6. INFORMATION TECHNOLOGY AS OPERATIONAL TOOL

6.1 The Software Suite that Manages the Complexity of the ALS Storage Ring

It should be considered a strength of ALS Operations and Controls Groups, that operators' contributions to programming are encouraged. At least two operators have contributed significant quantities of software to machine control and monitoring since 1991. This is facilitated by the fact that object-oriented and Windows-oriented programming environments and libraries specific to the ALS control have been provided to operators inclined to programming. Program SRInject, written by the author, [Fig. 1] is used to create new fill patterns and, at each storage ring refill, to start and stop the fill. It is slated for improvement in two ways: to include a fill enhancement routine which will equalize the charge in the SR buckets, and, if deemed feasible, provide automation of the entire fill procedure, including the insertion of the camshaft bucket.

The hardware used to connect the control room to the machine is implemented in two ways: 1) Using a database system, networked PC's are processed through the display micromodule (DMM) and collector micromodule (CMM), and connected by fiberoptics to intelligent local controllers (ILC's) at specific machine sites. Each ILC is equipped with 4 channels of ADC and DAC, and 4 boolean channels to exchange data with devices. 2) Workstations are connected directly to input-output controllers (IOC's) using ethernet links. Newer installations are implemented in IOC architecture.

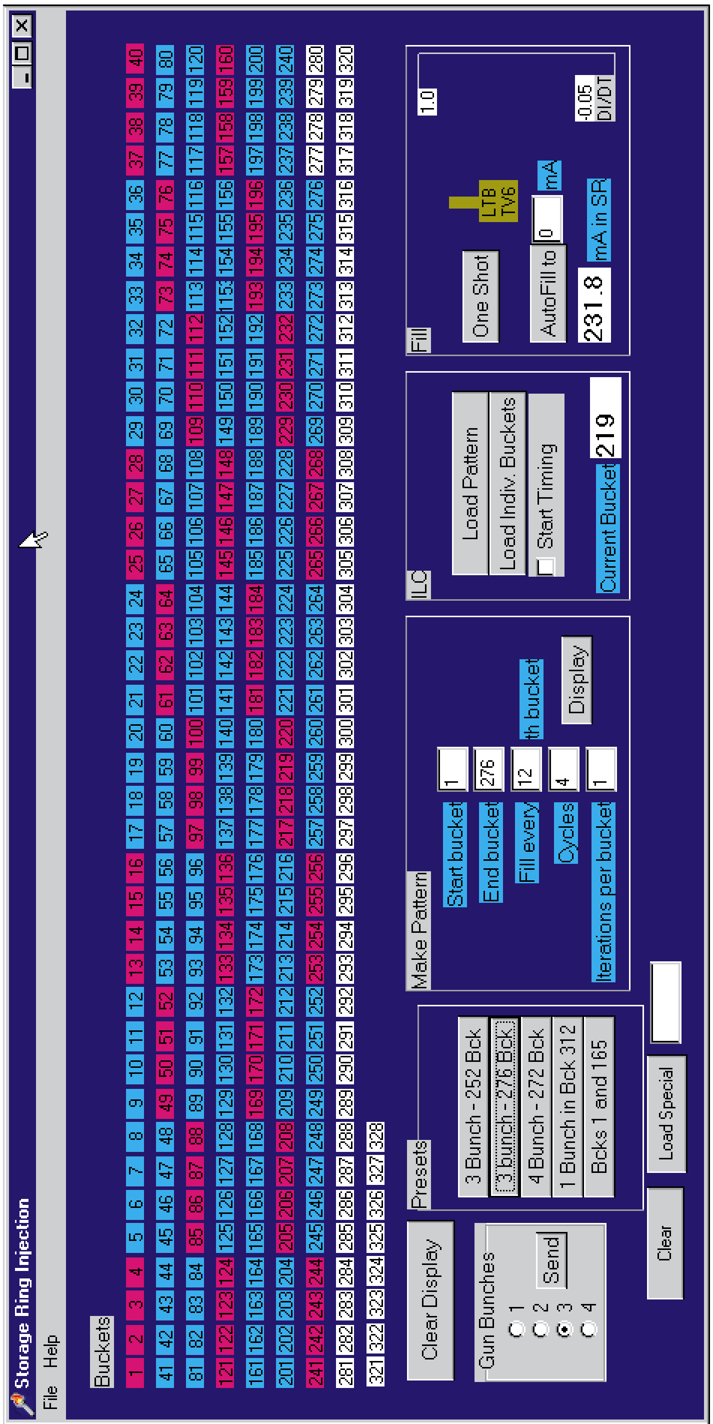
The software ensemble that runs the storage ring during user beam time consists of slow orbit feedback (SOFB), longitudinal and Transverse Feedback (LFB and TFB), RF Phase Control, Feedforward (FF), and Higher Harmonic Cavities (HHC).

- SOFB: A continuous orbit correction program. Regulates to within 5 microns, as measured in straight sections.
- LFB: Designed jointly at Stanford Linear Accelerator Complex and ALS, uses a digital signal processor farm and a quadrature phased shift keying system to damp synchrotron oscillations
- TFB: Damps horizontal and vertical bunch oscillations.
- RF phase control: Matches the phase of the RF power to beam phase. This was necessitated by problems with stability of the LFB system.
- FF: Compensates for beam misalignments caused by movement of insertion devices.
- HHCs: Enhances 3rd RF harmonic in the beam as it moves through passive cavities, thereby increasing beam lifetime by 50%. The cavities may be continuously tuned by this program to regulate the coupled power. Currently, it is in 'stretch mode' to improve lifetime.

These six programs run simultaneously and provide complete, automated control of stored beam parameters. Several of them (LFB – TFB – HHC) interact with one another, requiring detailed tuning in order to coexist. However when the machine is running well, which is increasingly the case, it may not be adjusted for days.

7. CONCLUSION

The use of information technology in daily life has introduced a host of problems along with its promise of a faster, more varied lifestyle. However, A vision of an appropriate application of IT might lie in its usefulness in governing the activities of large, complex machines. Running a large accelerator like the ALS is not a unique situation worldwide. The ALS uses only one subset of software that COULD be used to run an accelerator anywhere. The software suite described here is not only a fine example, but also an exemplary one. According to social philosopher Nick Lee, without a solution to complexity, time seems to move faster, causing the ultimate goal of a project - whether driven by convenience or curiosity - to recede precariously into future inaccessibility, and preventing a proper fixing of attention on it*.



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* Organized worlds: explorations in technology and organization with Robert Cooper, edited by Robert C. H. Chia, London, New York, Routledge, 1998.

BUILDING AN OPERATIONS GROUP

Pierre Bricault
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Abstract
The construction of the first phase of the ISAC Radioactive Ion Beam (RIB) Facility is completed. The facility uses the Isotopic Separation on-line (ISOL) method to produce the RIB. The ISAC facility at TRIUMF includes: a new building, a new beam line with adequate shielding to transport up to 100 µA of proton at 500 MeV from the existing H- cyclotron to two target stations, remote handling facility, a high resolution mass separator, a linear accelerator and experimental facilities.

The ISAC facility operation group was formed completely separated from the main cyclotron operation since it was recognized that during the commissioning of ISAC, operation of the new systems could be a distraction for the ongoing cyclotron operation. The new operation group is composed of nine persons: the head of ISAC operations, a training and documentation coordinator and seven shift operators. Because TRIUMF/ISAC is considered by the new Canadian Nuclear Safety Commission (CNSC) as a class 1 nuclear facility - and treated similar to nuclear power stations, the training approach of the new operators is somewhat different than in the past. The coordinator is in charge of putting a new training program in place. This training program is based on the 'Systems Approach to Training' developed by the 'Public Service Commission of Canada' that was adopted by the CNSC.

STRESS AND SHIFT WORK

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Abstract
Understanding the fundamental aspects of stress and the biological and physiological effects of shift working is an important step toward developing coping strategies. This presentation was designed to give the participants a better awareness of these aspects and propose several practical strategies designed to sustain the performance of shift workers whilst maintaining their health and quality of life.

The first part of the presentation was devoted to defining stress, describing its biological effects and the difference between positive and negative stress. Whilst positive stress results in optimal levels of energy, vitality, physical stamina and mental alertness, excessive stress induces negative stress which results in fatigue, irritability, lack of concentration and errors in discernment accompanied by physical symptoms which vary from one individual to another. The second part focused on describing the link between circadian rhythms, our biological clock and the alternating phenomena of catabolism and anabolism. The last part described typical problems related to shift work and several solutions.

The nature of shift work causes additional stress for the shift worker who has to constantly adjust to variations in natural circadian rhythms. The practical implications of carrying out activities, which do not necessarily correspond to peaks and troughs of the natural biological cycles, induces additional stress which has to be kept under control. In this respect, it is vital for shift workers to eliminate or reduce other sources of stress and to maintain their health and well being at optimal levels.

The solutions proposed and discussed include the following: managing the physical environment, optimal nutrition, physical exercise, relaxation exercises, frequent health checks, physical training facilities at work, avoidance of overload, development of teamwork, and longer holidays for better recuperation.

It is highly recommended that shift workers follow a special training program in order to cope optimally with the demands of the nature of shift working. Such a program would be designed to increase their knowledge of the physiological and psychological implications of shift working, show them how to identify sources of stress and how to eliminate or reduce them, motivate them to adopt an optimal lifestyle based on effective nutrition, physical exercise and relaxation, elevate and maintain their energy levels and performance, and lead them to an overall improvement of their quality of life both at work and at home. This preventive approach would be significantly beneficial to the individuals, their teams and the organization. It would motivate shift workers, responsibilize them for adopting an effective lifestyle, reduce errors of judgment and accidents, prevent illness, enhance communication / teamwork and reduce conflict, amongst other advantages.