# A RATIONAL APPROACH TO CONTROL SYSTEM DEVELOPMENT PROJECTS THAT INCORPORATES RISK MANAGEMENT*

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*Abstract*

Over the past year the Canadian Light Source has migrated towards a project management approach based on the Project Management Institute (PMI) guidelines as well as adopting an Enterprise Risk Management (ERM) program. Though these are broader organisational initiatives they do impact how controls systems and data acquisition software activities and planned, executed and integrated into larger scale projects. Synchrotron beamline development and accelerator upgrade projects have their own special considerations that require adaptation of these more standard management techniques. Our ERM processes integrate in two ways: (1) in helping to identify and prioritising those projects that we should be undertaking and (2) in helping identify risks that are internal to the project. These broader programs are resulting in us revising and improving processes we have in place for control and data acquisition system development and maintenance. This paper examines the approach we have adopted, our preliminary experience and our plans going forward.

## BACKGROUND

Increasingly in many research organisations there are two emerging trends that are impacting how projects in general and control system projects in particular are managed. The first is the adoption of PMI standards for project management. Though the underlying concepts are not new the PMI approach simply provides a standard nomenclature and approach for how projects are tracted and analyse the status of the project. The second trend is the focus on enterprise risk management and for some organisations compliance with ISO 31000. These two trends should not be approached in isolation but can build on each other in a symbiotic way.

This paper touches on both (1) the current state of affairs within CLS with the adoption of a ERM and a project management office and (2) going beyond the current state of CLS the authors views of what is necessary to effectively delivery projects in a synchrotron research environment.

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Given the nature of the thinking process around risks having a project team or entire organisation focused on reviewing risks can also help team members focus beyond their specific work areas and take a broader organisation wide view.

## COMMON TERMINOLOGY

Before going further it this discussion it is necessary to define some critical terms:

*Harm* – *1.* ERM - Damage to the Organisation; 2. Projects – Even that limits the ability of the project to be delivered; 3. Safety - Physical injury or damage to the health of people either directory or indirectly as the result of damage to property or the environment.

*Hazard* – The potential source of Harm.

*Knightian Uncertainty* – Risk that is immeasurable where do the nature of the risk there can be no scientific basis on which to form any calculable probability.

*Risk* – The combination of the probability of occurrence of harm and the severity of harm.

## FUNDAMENTAL CONCEPTS

When looking at risk it is important to consider the two aspects of risk: the likelihood (or expected frequency) that the risk will occur and the consequence or harm that the risk poses. This is important in helping to prioritise the risk and therefore in prioritising the mitigation actions that will be needed. This is commonly represented in a heat table where likelihood is plotted on one axis and consequence on the other, usually with some colour coding it is possible to clearly illustrate where the highest risks are located.

## THREE AREAS OF RISK MANAGEMENT

There are three areas of risk management that one needs to consider when it comes to control system project. These are:

a) Safety Risk,
b) Enterprise Risk and
c) Project Risk.

As shown in Figure 1 an individual risk may in fact fall into just one, two or all three areas. Organisationally this can pose challenges since in many cases the key stakeholders, relative importance and desired mitigation may be different in the three areas.

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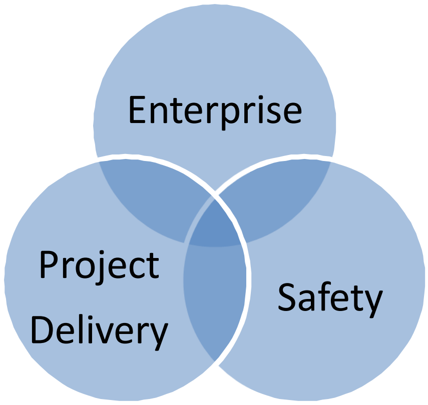


Figure 1: Relationship of risks.

*Project Risk*

In the case of project risks, we are concerned with those issues that cause harm to the project; in other worss that limit the ability for the project to be delivered on time, on budget and on schedule.

*Safety*

When looking at all of the control systems required for an accelerator in almost all cases a safety system of some sort requires functionality that protects people from radiation. One tries to partition the design of the control system as a whole to limit the safety functions to occurring within as small a subsystem as possible and to segregate it from the rest of the control system. Various approaches are available some quantitative and some qualitative.

There are fairly structured processes using keywords and by detailed examination of the system and its use that are used to identify hazards and associated mitigiation.

Examples of safety risks broadly include radiation exposure and physical harm to workers or the general public. Additional information on how CLS approaches Safety Hazard Analysis can be found in [1].

*Enterprise Risk Management*

Increasing in industry, government and higher education there has been a broad movement towards the management of risks at the enterprise level. The CLS and University of Saskatchewan is no exception. This involves a facilitated process to engage staff and stakeholders in identifying potential risks. These are analysed and prioritised in a systematic way.

Risks identified in this context are broad and diverse in nature. For example harm to reputation of the organisation, its ability to obtain funding, or inability to operate due to major equipment failures are all examples that come out of a systematic ERM process applied to an accelerator facility.

## THE PROJECT RISK REGISTRY

Creating and maintaining a risk registry for the project is important. Such as registry should at a minimum capture (1) the risk details (impact, and likelihood) as well s what mitigation is being undertaken.

I have seen large projects at several accelerator facilities develop such registries in SharePoint, or Spreadsheets. This is a good first step in capturing the risks, identifying the risk owner and track risks until they are retired. These tools generally lack the granularity that can be provided by certain commercial risk and QA management tools that are available on the market to manage PMO offices with integrated ERM processes. (i.e., SE Suite).

In the case of small projects anything beyond a spreadsheet is overkill unless developed for the broader organisation.

In the case of CLS, extensive work has been done on developing a ERM risk registry and the processes around its management. The process for developing safety risk registries is well established and has been in use for several years. Work is still need to move project risk management into a form that better integrates with the other processes.

## USING RISKS TO DRIVE PROJECT PRIORITISATION

At many labs one of the challenges is how to prioritise work especially when there are more “good ideas” than resources to accomplish them and decision making is decentralised across different organisational units.

The ERM process forces an organisation to look broadly at what are the threats to the success of the organisation and to rank them, present them in a heat table where each risk is prioritised. These risks can be very broad from safety, to equipment failure, to funding considerations, to being scientifically competitive. At that point there is much broader focus on identifying the problem that needs to be solved. Individual projects then arise as mitigation to address each of these risk.

The same should and can happen within the projects, where the project team looks at what are the risks to successfully delivering the project, what is the mitigation that would be needed and can make a structured decision on where mitigation is needed and where it is not.

## ANALYSIS OF PROJECT RISKS

The PMBOK has many suggested analysis techniques that could be applied. Some of these are quite sophisticated and some involve the application of monte-carlo simulation techniques to the project budget and schedule. These techniques do work when applied correctly on well understood problems, however in the case of most smaller scale accelerator projects they are overkill and the return is not worse the effort. Judgment is needed on when to apply one technique over another.

It is also interesting to consider Knightion uncertainty, I have seen some projects where at the start of the project there were serious questions on if the entire project is even feasible and achievable. In those cases it is difficult to



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impossible to establish a likelihood of the risk occurring. That said it is still important to analysis the risk so that stakehoders actually understand the ramifications of the project that is being undertaken.

In the case of scientific projects many of the risks I have encountered come down to (1) doing things for the first time and not knowing if the given approach will even work within the time/budget constraints, (2) vendors coming in over budget or behind schedule and (3) underestimating integration and commissioning. There are others, but those three tend to stand out.

## COMMON MITIGATION

In the case of doing things for the first time, that is the nature of running a research project. It should be a risk front-and-centre and a fair bit of analysis may be needed to decide on appropriate contingency plans, when and where prototypes should be developed and how to develop the necessary skills or knowledge to retire the risk. In many cases developing the necessary skills may involved building prototypes or developing computer models or undertaking studies. These are after all R&D projects and one expects such attributes of some of the projects we undertake.

In the case of vendors, I have been a strong believer in going to the market and procuring vendor furnished components or sub-systems as early as possible and carefully monitoring vendor progress to avoid delays. The interfaces between vendor furnished systems can be tricky to get worked out especially when they are between two different vendors. At that point we are back to the integration issue.

The control system fundamentally is the interface and glue that holds many of these systems together. This varies from laboratory to laboratory but in many cases the controls staff are the system integrators. They can in many cases be the one group that touch and interacts with all of the control systems and must resolve the fundamental integration issues.

Addressing the integration risks and developing appropriate mitigation must happen very early in the project long before the problems manifest themselves. How to establish these interface points and the dialogue that is necessary between different organisations within the laboratory and even between suppliers is challenging and in many cases requires explicit upfront planning and for the someone to facilitate the dialogue.

## PAYING ATTENTION

This is surprisingly the key thing a good project manager does that does appear in any of the temples people use for generating project plans, building budgets or schedules. Fundamentally working with staff developing an understanding with what is working and what is not is key.

This goes hand-in-hand with creating an environment where it both acceptable, encouraged and eventually expected that when a project is reviewed it is fundamental a time to challenge assumptions, questions what is being done and drive innovation.

The project management and project staff for that matter tend to decide fairly early on who is along for the ride and who is in face steering the project and in which direction.

## CONSTRAINTS VRS. CREATIVITY

Implementing mitigation from analysing the project risk is fundamentally about imposing constraints on a project. With some scientific staff this is sometimes viewed as constraining creativity especially when the constraints involve: extra QA checks, reviews, more upfront design. These things should be in place for a specific purpose and mitigate a specific risk, if not they are fundamentally a hindrance to the success of the project. That said, there will also be a need for such constraints and the reason they are being introduced and maintained in place must be clearly communicated.

To often there is a view that such constraints undermine creativity and the scientific process. That is only the case if the controls are there for no reason and act a hindrance. If they are necessary then they in fact help shape the problem and the creative process.

Many people in the arts community have spent a great deal of timing studding creativity/innovation and there is a widely held school of thought that creativity and innovation only comes from constraints placed on acceptable solutions.

## SOFTWARE

The decision to use software to aid in project management is always a tricky one. Today most organisations use a Gantt charting package of some sort, at the other extreme are Enterprise Resource Planning systems such as SAP. The trick is picking the correct tool to use that does not detract from the project management function.

Mighty Oaks is beginning to partner with Soft Expert to facilitate the deployment of a platform that is tailored around the specific needs of managing engineering projects of this nature. That said, such approaches are only appropriate for organisations of a certain size and that are ready to adopt such systems. Care is required to ensure that the automation actually facilitates the successful delivery of the project instead of detracting from it.

## CONCLUSION

The application of structured risk analysis is challenging. Some facilities such as CLS have aspects of it that are well developed (ERM and Safety) and are still working on others.

There are some unique attributes to the types of risk one finds in an R&D environment and care is require to identify those and develop appropriate mitigation that provides value instead of impeding the success of the project. Most importantly the project management needs to pay attention and adapt to what is going on.



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## REFERANCES

[1] Matias, E. et al. “A Hazard Driven Approach to Accelerator Safety System Design – How CLS Successfully Applied ALARP in the Design of Safety Systems,” ICALEPS 2013, San Francisco. In Press.



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