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At Your Self-Service: One Organization's Journey from Mainframe Reporting to Enterprise Business Intelligence

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ABSTRACT

The University of Victoria's Project NOVA replaced a number of technologically dated stand-alone systems with a state-of-the-art information technology infrastructure that integrates Student, Human Resources, Finance/Accounting, Alumni, and Facilities Management components. The change in infrastructure required the replacement of hundreds of mainframe reports that supported a variety of operational and strategic reporting processes. To meet mandatory British Columbia provincial government accountability requirements, the first priority was to replace the university's Student Enrollment Management reporting, which provided a rare opportunity to re-evaluate, re-invision, and re-structure all student-reporting processes. This paper discusses the journey from product selection to production SAS® Enterprise BI Server Web portal implementation and every step in between. Challenges faced, benefits achieved, tips learned, and future steps are presented.

INTRODUCTION

In 2005, the University of Victoria (UVic) decided to upgrade its outdated information systems. Since the 1980s, the legacy infrastructure consisted of a number of stand-alone information systems that mainly resided on an IBM 3270 mainframe:

- **Computerized Human Resource Information System (CHRIS)** tracked staff and provided payroll functionality;
- **Course Update System (CUS)** stored course attribute information;
- **Computerized Room and Booking System (CRABS)** made use of data in CUS and allowed for course scheduling and room bookings;
- **Integrated Student Information System (ISIS)** contained all student admission, registration and credential information;
- **Development & Alumni Information SYstem (DAISY)** was an in-house alumni tracking system.

CHRIS, CUS, CRABS, and ISIS were custom built and were based on an ADABAS database (a type of inverted list database). While ADABAS was relational-like in nature, it was not a relational database in the modern sense.

The new information system was scheduled to go into production in May of 2008, replacing the old infrastructure with four components of an Oracle-based higher education specific product called Banner:

- Banner Advancement (alumni tracking);
- Banner Student;
- Banner Finance;
- Banner Human Resources.

The change to Banner also meant hundreds of mainframe reports that had supported a variety of operational and strategic reporting processes would no longer be available after May 1, 2008. This situation presented a huge challenge: replacement of hundreds of reports. The situation also provided a rare opportunity to re-evaluate, re-vision, and re-structure the processes we had in place regarding campus reporting. Because of the number of reports to be replaced, it was clear that we must proceed in phases. With that approach in mind, we determined the first priority must be to replace the university's Student Enrolment Management reporting in order to meet mandatory British Columbia (BC) provincial government accountability requirements.

UVic's office of Institutional Planning & Analysis' (IPA) primary role is to provide information, research/statistical support, and other analytical services to support operational and strategic decision making and policy planning at UVic. In addition, our office is responsible for the analysis, preparation and submission of official accountability data and reports to the government of BC. Given the roles and responsibilities of IPA, the UVic Reporting Committee saw our department as a natural choice to manage the reporting replacement initiative, a process which began in late 2006.

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REQUIREMENTS

Since the Banner suite is not well-suited for report delivery, the reporting strategy articulated the need early on to acquire a comprehensive set of tools that would complement the new transactional system and allow for:

- ad-hoc querying;
- point-in-time reporting;
- time-series reporting;
- simple to complex statistical analysis;
- automation of the data extract, transform, and load (ETL) process from the student information system;
- timely report updates with weekly data refreshing (automate if possible);
- web-based custom reporting;
- campus clients could access reports using their existing single sign-on credentials;
- the ability to add predictive analytics to our infrastructure in the future.

Any tool (or tools) we selected needed to have the ability to connect with disparate systems on campus and support a phased approach to implementation.

PRODUCTION SELECTION

The UVic Reporting Committee identified a number of candidate products we felt might fit our requirements:

- Oracle Reports
- Cognos 8 (pre-IBM purchase)
- SAS[®] Business Intelligence 9.1.3

During the early part of 2007, we invited these three companies to provide the Committee with a full-scale, onsite demonstration of their suites of software, customized to fit our needs—as much as they could for demonstration purposes. We also requested technical staff from each of these companies to meet with our computing staff in order to investigate deeply the strengths and weaknesses of each product and to help us identify the pros and cons of selecting each product for implementation.

Our technical staff had determined that implementation of Banner's Operational Data Store (ODS) would not meet our needs. We determined that, at a minimum, each of these three products would have the ability to complement and facilitate the design and implementation of a custom data warehouse for all extracted Banner Student data. The Committee and our technical staff noted the following during the evaluation process:

- All products provided the following pros:
 - easy communication with disparate systems on campus;
 - a common interface for single sign-on;
 - the ability to provide snapshot (point-in-time) and time series reporting;
 - a way to construct automated data extracts;
 - the ability to implement automated weekly data refreshes;
 - for phased implementation.
- Oracle Reports provided the following pros:
 - a natural extension of the new information system, as Banner is Oracle-based;
 - staff already trained in Oracle PL/SQL;
 - would allow for simple statistical analysis via built-in PL/SQL functions;

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- Oracle Reports provided the following cons:
 - did not have the ability to create OLAP cubes;
 - did not offer a business intelligence architecture.
- Cognos (pre-IBM purchase) offered the following pros:
 - allowed for simple statistical analysis;
 - partially realized business intelligence architecture that would support future expansion of forecasting and modeling components;
 - web portal for clients to access and customize standard reports;
- Cognos (pre-IBM purchase) had the following cons:
 - did not have a strong statistical engine (in 2007);
 - no one, apart from our Internal Auditor, had any experience with business intelligence, thus all staff involved in this project would face a huge learning curve to adopt a new information paradigm.
- SAS[®] Business Intelligence 9.1.3 offered the following pros:
 - SAS[®] language specifically constructed to provide statistical analysis from the simple to the very complex;
 - fully realized business intelligence architecture that supports future expansion of forecasting and modeling components;
 - web portal for clients to access and customize standard reports;
 - our Internal Auditor had installed and was running a full SAS BI 9.1.3 installation to regularly analyze and audit data from a variety of information systems on the UVic campus.
- SAS[®] Business Intelligence 9.1.3 had the following cons:
 - no one, apart from our Internal Auditor, had any experience with business intelligence or SAS BI, thus all staff involved in this project would face a huge learning curve to adopt a new information paradigm and suite of software.

We had a rare opportunity before us: we were in a position to redesign completely our entire campus data collection and reporting strategy from the ground up. To make the most of this situation, we decided to invest in a business intelligence (BI) platform. Business intelligence systems provide not only reporting functionality, but also facilitate the identification, extraction, and analysis of data with a view to providing additional information that supports better business decision making, taking into account an institution's business rules and strategic goals. A properly constructed BI system would allow for UVic's specific business rules and strategic goals to be reported and monitored plus would allow us the flexibility to add forecasting and modeling components in the future.

Since UVic possessed a campus-wide license for the SAS[®] Academic Premier suite of software, and our Internal Auditor had already installed and been using the SAS[®] BI software, we decided to leverage our existing investment in SAS by purchasing the SAS[®] Business Intelligence suite for all the above listed reasons, as well as the following product-specific features (not offered collectively by either of the other two vendors):

- **SAS Enterprise BI Server:** Allows for business metadata management. Create and centrally store native SAS[®] datasets, as well as provide a common interface to the wide range of disparate information systems on the UVic campus;
- **SAS[®] OLAP Server/Cubes:** Create **On-Line Analytical Processing (OLAP)** cubes to pre-summarize data for fast retrieval and analysis;
- **SAS[®] Information Map Studio:** The ability to create an interface to our disparate information sources that users can use to access data or create reports via SAS[®] Web Report Studio or Microsoft Office (without the need to know exactly where the source data comes from);
- **SAS[®] Web Report Studio:** Provide a web-based report building, distribution, and advanced data exploration using traditional tables and/or charts;
- **SAS[®] Web Portal:** Serve up our reports via an interactive web interface that did not require us to install any special software on 2,000+ desktop user's machines on campus (all faculty and administrative staff), rather than email or print hundreds of reports each week. The ability to provide a common version of data "truth."

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- **SAS® Enterprise Guide®**: Access disparate data sources via the SAS metadata server. Query, manipulate and analyze local and networked data sources via the metadata server. Potential for automated processes and report creation. Allow for detailed, complex analysis of our data.
- **Microsoft Office Integration**: Directly access SAS datasets, SAS stored processes, and SAS Information Maps from menus within MS Word, Excel, Access, and PowerPoint thus reports can re-populate with the most up-to-date information.

A MULTI-PHASED APPROACH

Given the extent of mainframe report replacement required—hundreds of reports spanning the Student, Human Resources, Alumni, and Facilities Management areas—we decided to employ a multi-phased approach:

- Phase 1: Create a development environment to meet mandatory governmental reporting requirements;
- Phase 2: Move development environment objects and processes into production and make available to all faculty and administrative staff;
- Phase 3: Augment the system with additional high priority Student reporting components.

Once we completed Phases 1 – 3, the UVic Reporting Committee would determine the next highest priority regarding business intelligence reporting. Subsequent projects would be implemented one by one as time, money, and resourcing permitted.

PHASE 1: SAS® DEVELOPMENT ENVIRONMENT

This phase began at the end of November 2007 and circumstances were such that we had to be in a position to meet our mandatory BC provincial reporting requirements by August 1, 2008. This meant we had a hard and fast deadline and had to be in a position to correctly extract, transform and load student enrolment data from Banner Student in eight months. Timelines were extremely tight for us to learn, develop, test, and implement a completely new-to-us technology! Thus, it was an easy and necessary decision to engage the services of two contractors: an installer to help us install and configure a development and production SAS® Business Intelligence environment; and a developer to help us get up and running with the BI paradigm.

In the fall of 2007, we engaged a contractor to install and configure our development servers in a Windows-based environment. Figure 1 below illustrates the configuration we chose: one physical machine to host the data and server tiers (named Aardwolf); a second physical machine to host the web and client tiers (named Grouse). The metadata server resides on Aardwolf and is the connecting link not only to Grouse, but also to the variety of disparate information sources on the UVic campus.

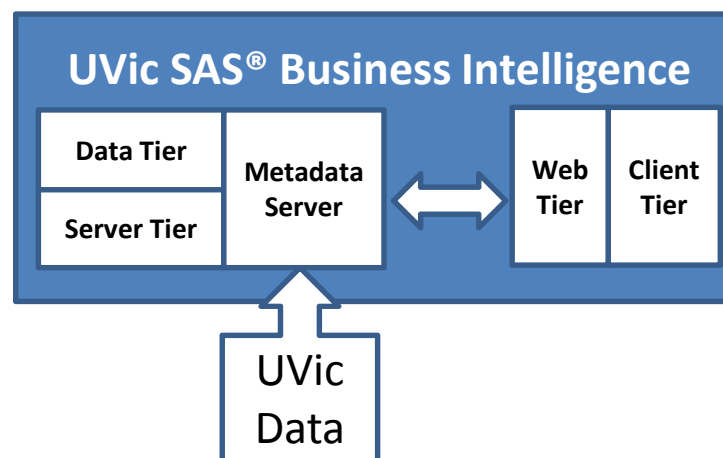


Figure 1. Conceptual overview of UVic's SAS® Business Intelligence architecture

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During the course of the BI install and configuration of the development servers, our UVic staff member who was to oversee this process fell gravely ill, thus minimal knowledge transfer occurred during this process. The situation was unexpected and, at the time, could not be avoided due to a shortage of staff availability. Once we had our development environment up and running, we engaged the second contractor to help with implementation.

It was decided that our two UVic developers would focus on the Banner extract, transform, and load (Oracle ETL) of student data into a custom-built Oracle data warehouse and that we would then have our contractor focus on the BI consumption of student data into SAS® datasets, cubes, and SAS® Web Report Studio reports. Also included in the contract was maximal knowledge transfer between the contractor and our UVic staff such that at the end of Phase 1 we would be self-sufficient to not only maintain what we had put in place but continue with Phases 2 and 3 without the need to engage another contractor to provide development services.

After much discussion, we decided that the simplest and quickest approach to share the workload and to expedite design and implementation would be to have our Oracle ETL provide a specially constructed Oracle view of Banner Student data to our BI architecture. Figure 2 shows the flow of data from Banner Student through to report presentation in the SAS® Web Portal.

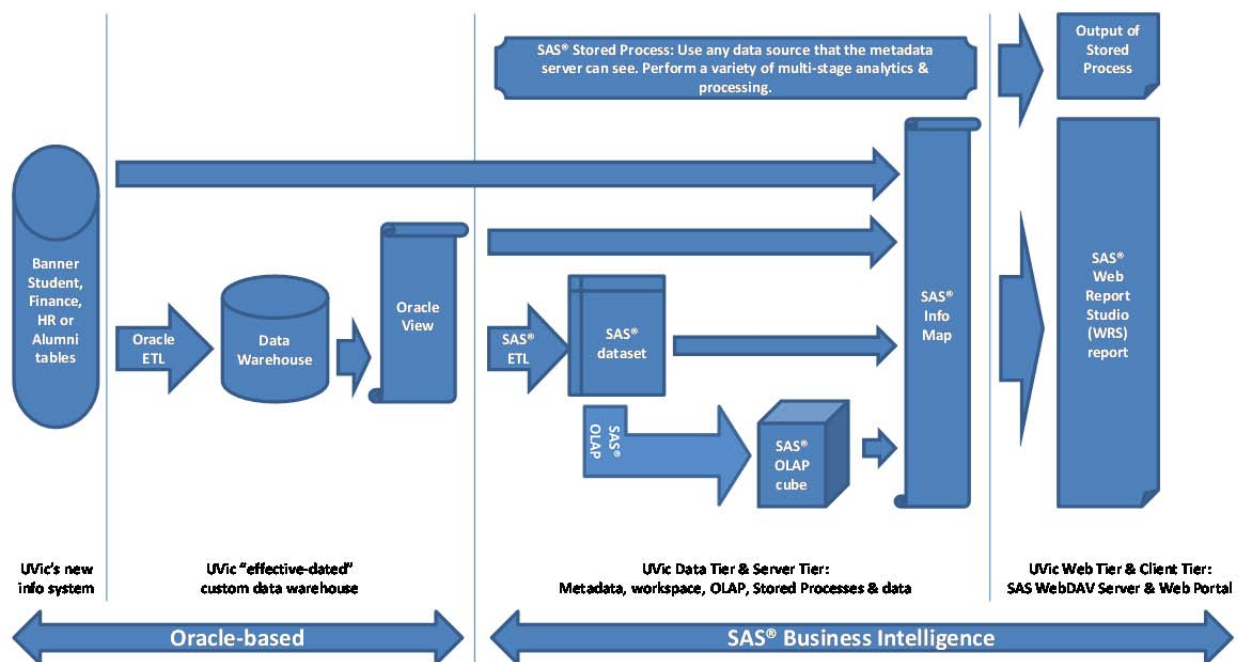


Figure 2. Flow of data in UVic's SAS® BI implementation

The flow of data through our BI platform involves seven major steps:

1. Oracle ETL extracts data from Banner and stores it in a custom-built Oracle data warehouse. Government accountability reporting requires us to have the ability to store and report on both single point-in-time snapshots and time-series data. Since Banner does not provide the ability to store and retrieve "point-in-time" data extracts, the design and implementation of a custom warehouse was a mandatory part of Phase 1. The concept of "effective-dating" of data extracted from Banner was designed and implemented in a custom Enterprise Data Warehouse (named SAS_EDW).
2. Data from SAS_EDW is consumed by an Oracle view presented to the SAS metadata server on Aardwolf. This view incorporates the cardinality of the dataset required to properly construct our OLAP cubes and SAS Web Report Studio reports.
3. Our SAS ETL then uses the Oracle view to consume stored data in order to construct a SAS dataset.
4. Our SAS OLAP code then executes to build one or more associated cubes.
5. To make the pre-summarized data in the cubes available to the web portal, SAS® Enterprise Guide®, and the MS Office plug-in, a SAS® Information Map is constructed and used to reference some or all of the dimensions (ways

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to group data) and measures (ways to count the data) present in the cube.

6. SAS® Web Report Studio then refers to predefined Information Maps as a source of data for web report construction and viewing, which is done on our web/client server (Grouse). The reports are stored on the data/metadata server Aardwolf.
7. The web reports are then made available in the SAS® Information Delivery Portal (on Grouse) for use by clients when they log into the portal using their campus-wide single sign-on credentials.

In July of 2008 we were far enough into the development and testing cycle for Phase 1 in order to meet our government accountability reporting requirements. Thus, on August 1, 2008 we were in a position to use our Oracle ETL and custom data warehouse to extract the “official” snapshot of data from Banner Student for the summer 2008 academic term, thereby meeting our requirements.

By the end of November 2008, one year after starting, we completed Phase 1 of our BI implementation having also successfully created three SAS ETLs, datasets, cubes, Information Maps, and accompanying web reports for the following student data:

- **Course Populations:** Course section registration data used to manage, monitor and forecast internal faculty and departmental enrolment targets as set by the Provost.
- **Student Program:** Academic program sought along with demographic data, headcounts, and Full-Time Equivalent enrolments (FTEs). This data is used to manage, monitor and forecast internal FTE targets (university, faculty, and departmental levels) and BC government accountability (FTE) targets.
- **Student Registration:** Course registration data combined with subset of fields from the Student Program dataset. This dataset facilitates a detailed examination of faculty and department course offering in conjunction with student characteristic data. Thus, academic units can profile students taking their courses, examine and analyze courses “their” students are taking, and measure academic performance (by gender, age, year, program, faculty, etc.).

PHASE 2: SAS® BUSINESS INTELLIGENCE PRODUCTION ENVIRONMENT

In early December 2008, we began Phase 2. The main objectives of this project were to create a production SAS BI environment, migrate all development objects to production, and make the production objects available to faculty and staff on campus (2,000+ people).

Because of the lack of knowledge transfer during the install and configuration of our development servers, we found it necessary to contract a second installer to help us properly install and configure an identical set of servers for our production environment (see Figure 1). The data and server tier for production were installed on a physical machine named Bluejay and the web and client tiers were installed and configured on a physical machine called Finch.

The next step saw us migrate all development objects to Bluejay. We then designed and implemented an automated account provisioning process to take advantage of our campus-wide single sign-on infrastructure. We were able to obtain and customize an account provisioning script from SAS that makes use of the Lightweight Directory Access Protocol (LDAP) that is available to us via the Windows Active Directory portion of the UVic identity management system.

Defining and implementing user permissions and object security—using SAS Access Control Templates (ACTs)—was carried out at the same time as the design and construction of 30+ Web Report Studio reports that made use of our three cubes. Once the reports were constructed and tested in development, we migrated them to the production environment. It was decided that a limited set of users would be given permission to access the record-level SAS datasets via Enterprise Guide, while all faculty and staff were given permission to the 30+ web reports in the production Information Delivery portal.

We made the decision to carry out a soft launch of our production BI system in order to allow for an organic adoption of this new technology by our faculty and staff. Rather than making a splashy announcement, we decided to schedule and organize training sessions for key personnel in each administrative and academic unit to act as champions of the new system and train other users. It was hoped that over time, word would spread about the value of the portal and other users would start using the system. In this way, we hoped to avoid a previous situation where we had launched a new technology that initially had some glitches, which resulted in a high percentage of clients experiencing frustration and difficulty, leading to low user acceptance.

After initial training sessions, most users were thrilled with the volume of data available to them, however a significant percentage of them reported feeling overwhelmed by the new interface. Consequently, subsequent training sessions

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were modified to focus on the basics of using the new reporting tool, as well as explanations of the meaning of data presented in the default view of each report. Clients were delighted to discover that default reports could be modified during a portal session to suit their individual and academic unit's needs. Sometimes report modification was taught in groups and other times one-on-one training was required.

PHASE 3: STUDENT LIFECYCLE PROJECT

In July of 2011, we began the third phase, the intention of which was to augment our production BI system with the addition of the following types of student information, which was collectively known as the Student Lifecycle project:

- Recruitment/Applicant/Admission/Registration:
 - Understand the flow of students through these four stages (conversion & yield rates).
 - Profile students and chosen programs at each decision point in the process in order to inform timely interventions throughout the cycle.
 - Faculties and departments being required to become more directly involved in recruitment in order to meet internal and external government-mandated enrolment targets.
- Retention: Examine UVic and faculty-level retention from year-to-year and fall-to-fall for use in academic program review and enrolment management.
- Credentials Granted: Detailed student outcomes for program review, ceremonies planning, and government accountability.
- Graduation Rates: Examine UVic and faculty-level graduation rates for program review, enrolment management, and government accountability.
- Indigenous Students: Provide government mandated reporting regarding the above data, specific to Indigenous students who have either self-declared or who have ever been considered "Indigenous" by any of BC's public K-12, colleges, or universities.

The bulk of this phase was completed at the end of August 2011. The remainder is scheduled to be completed in May 2012.

BENEFITS AND ACCOMPLISHMENTS

Phase 1 enabled us to create a SAS® Business Intelligence development environment in order to extract student data from Banner for numerous snapshot dates, including five key reporting dates: August 1st, September first day of fall term, October 1st, November 1st and March 1st in order to:

- meet statutory government accountability reporting;
- provide internal enrolment monitoring and reporting;
- obtain monthly/weekly Banner extracts to feed the reporting system;
- load "historical" snapshot data from before the implementation of Banner;
- provide access to the reporting system for a select group of users.

Phase 2, implementation of our production environment, enabled us to:

- make a production version of our BI system available to the wider UVic audience (all faculty and administrative staff) at no additional cost per user because of server-based licensing;
- provide a common reporting interface and the official statistical reports of student data;
- train staff to use and customize the 40+ web reports.

Phase 3 enabled us to augment our production environment to provide the following data to both internal and external stakeholders:

- recruitment reports (updated weekly);
- applicant reports (updated weekly);

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- retention reports (updated yearly);
- graduation rate reports (updated yearly);
- credentials granted reports (weekly or monthly);
- basic student funding data (updated yearly);
- test score data (updated weekly or monthly);
- Indigenous reports.

Completion of this phase allows us to perform more complex and detailed analysis, modelling and forecasting regarding our students using individual datasets and by combining datasets.

CHALLENGES OVERCOME DURING IMPLEMENTATION

The following are the major challenges we faced during implementation:

- Tight timelines during Phase 1 required us to hire a contractor to help us quickly learn and implement our new BI infrastructure.
- Sudden staff unavailability resulted in a lack of knowledge transfer during Phase 1's installation and configuration of our development servers. This resulted in the need to hire a contractor to help us install and configure our production servers.
- In all phases, ETL took the most time because of the large number and complexity of Banner Student tables. Once data has undergone the ETL process it can be used in virtually any business intelligence or reporting tool.
- Large amount of time investment required to learn new tools and construct reporting data warehouse infrastructure (Oracle-based, in our case). Time required to learn new business intelligence paradigm; for example, what is an OLAP cube, and information map, and how does one properly design and construct cubes and maps to facilitate drill-through reporting and data exploration?
- Institutional resource limits. Time to complete each stage and expansion of Reporting System is always dependent on staff availability, time allowed, and money available (purchase hardware, software licenses, contractor if needed, etc.).
- Moving to a new campus information system posed numerous data and process validation problems. The old system stored data using an eight month session-based paradigm, while the new Banner Student information system uses a four month term-based paradigm. Because of the new data paradigm, there was no comparable data for use during User Acceptance Testing and validation. The best we could do was "Bannerize" a portion of historical data in an attempt to construct comparable datasets and reports to examine results from the old system vs. our new implementation.

BUSINESS NEEDS MET BY SAS® BUSINESS INTELLIGENCE IMPLEMENTATION

UVic realized the following benefits by making the choice to purchase and implement a SAS® Business Intelligence infrastructure:

- Automated processes to schedule and run our Oracle and SAS ETL to extract and move data from Banner Student through all steps outlined in Figure 2 and serve up the data in report form to all clients via our Information Delivery portal.
- Once datasets and cubes are created, multiple reports can utilize the same dataset or cube in order to facilitate different audiences or levels of access to underlying data.
- When new data is available and loaded into datasets and cubes, all reports associated with a specific dataset or cube are automatically refreshed (in our case, weekly, however this could be done as often as is required).
- Server-based licensing means no additional costs are incurred to expand our client base.
- SAS® Metadata Server can act as a hub to link disparate information systems, while presenting users with a common interface.

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- The web portal provides a common interface for data and report retrieval; no special software is required by our 2,000+ provisioned information consumers other than Internet Explorer or Safari. The web reports available in the portal provide standardized reporting (and data calculations). Thus, a uniform version of the official university statistics are presented across campus for all internal and external stakeholders to use for accountability reporting and planning. Also, we avoid the situation where individual units calculate their own statistics using non-standard methods.
- Internet Explorer is used to access the development version of our SAS® Web Report Studio, which provides developers with a common interface to create and update portal reports. No additional desktop software is required for web report creation. A single SAS administrator can make these reports available in the web portal.
- We were able to construct ETL and reporting processes to support, report, and monitor our institution's strategic goals regarding student application, admission, registration, retention, credentials granted, and graduation rates enabling us to monitor the complete lifecycle of a student's academic experience at UVic. Business intelligence allows us to model and make predictions for the above areas.
- The self-serve nature of the web portal allows clients access to web reports they have permissions to view on demand.
- The pre-summarized nature of the OLAP cubes enables rapid access to complex statistical data.
- We have established a firm foundation from which the university can expand its reporting needs to other areas (HR, alumni, etc.).

LESSONS LEARNED

Going forward in future phases, we will benefit from the following lessons learned:

- Knowledge transfer ensures there are backup staff resources available within the organization in case there is a need for a contingency plan.
- Contractors are valuable to expedite initial planning and development, despite the inherent limitations to their knowledge of your data and reporting requirements. Therefore, it is wise to involve subject matter experts, familiar with your data, early on in the requirements gathering stage so that they can augment the contractors limited knowledge and ensure that the correct data elements are used.
- Use of the SAS® technical support system enables rapid solution of problems encountered during implementation. We found SAS® support to be first class.
- In all stages, data extract, transform, and loading (ETL) took the most time. Plan for this to be as much as 80% of your development effort. Once data is prepped, it can be used by any business intelligence or reporting system. However in our experience the SAS® Business Intelligence suite provided an excellent solution to our needs.
- Wide consultation amongst all stakeholders in the requirements gathering phase and plenty of time for client participation (and sign-off) during User Acceptance Testing goes a long way toward guaranteeing confidence in and use of the business intelligence system.

CONCLUSION

UVic implemented a new information system across campus. This situation posed both a huge challenge as well as a unique opportunity. The challenge was replacing hundreds of legacy mainframe reports that had been developed over decades. The opportunity was the ability to re-think, re-design, and adopt a new campus-wide business intelligence paradigm that would allow for a modern web-based reporting interface.

The time and effort invested by UVic to design and implement our SAS® BI infrastructure has paid off with a robust, automated, and highly accessible web-based reporting system. Our users report being highly satisfied with:

- the amount of self-service data now available to them;
- the quality and uniformity of single snapshot, as well as time series, data reported;
- the ease with which they can access default report views, as well as customize the very same reports;
- our ability to provide automated data refreshes for all reports on an as needed basis.

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Phases 1 – 3 position us to perform more complex and detailed analysis of our individual datasets, as well as by combining elements across our datasets. We are also in a position to further expand our SAS[®] Business Intelligence infrastructure by adding forecasting and modeling components in the future. Imminent projects include an upgrade to SAS[®] 9.3, as well as the addition of human resources reporting.

ACKNOWLEDGMENTS

Thanks must go to all UVic staff that contributed to the success of adopting, supporting, and championing our SAS[®] Business Intelligence infrastructure since the fall of 2007. In particular, I'd like to thank Mike Motek and Vincent Connor for their tireless dedication that was instrumental in the success of all phases of development.

RECOMMENDED READING

- Overview of SAS[®] 9.1.3 Intelligence Platform

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