

ACADEMIC COUNCIL REPORT

ACTION REQUESTED:

Recommendation	<input type="checkbox"/>
Decision	<input type="checkbox"/>
Discussion/Direction	<input type="checkbox"/>
Information	<input checked="" type="checkbox"/>

DATE: 23 November 2021

FROM: Undergraduate Studies Committee

SUBJECT: Program Review Final Assessment Report – Bachelor of Science in Applied and Industrial Mathematics

COMMITTEE MANDATE:

In accordance with Article 10 of the Ontario Tech University Institutional Quality Assurance Process (IQAP) Cyclical Program Review (CPR) Procedures, the appropriate standing committee of Academic Council (USC or GSC) is responsible for examining the outcomes of the review and approving the Final Assessment Report (FAR). This report will be presented to Academic Council for information and subsequently posted to the Ontario Tech corporate website.

Additionally, in accordance with Article 6 of the IQAP Curriculum Change Procedures, editorial revisions to Program Learning Outcomes are considered Minor Program Adjustments and are sent to the standing committee for approval. Minor Program Adjustments are presented to Academic Council for information.

BACKGROUND/CONTEXT & RATIONALE:

In academic years 2017-2019 a program review was scheduled for the Bachelor of Science in Applied and Industrial Mathematics. The site visit was conducted in March 2021. At the completion of a CPR the self-study brief, reviewers' report(s), Dean's and IAT's response, and the Academic Resource Committee's (ARC) summary report are presented to the appropriate standing committee of Academic Council (USC or GSC).

The standing committee will examine the outcomes of the review and approve a Final Assessment Report (FAR) that synthesizes the reports and recommendations resulting from the review, identifies the strengths of the program as well as the opportunities for program improvement and enhancement, and outlines the agreed-upon implementation plans for this improvement.

Additionally, during a CPR the Program Learning Outcomes (PLOs) are reviewed and revised. If these revisions are deemed editorial in nature, they are included with the FAR for approval by the standing committee, in accordance with the procedure for Minor Program Adjustments.

A report from the program outlining the progress that has been made in implementing the recommendations will be put forward in eighteen months' time. The report is sent to ARC for review. If outstanding items remain from the implementation plan at the time of the eighteen-month report, ARC will review these outstanding items with the Dean. The Committee may recommend further monitoring of these items on a case-by-case basis.

RESOURCES REQUIRED:

The Faculty's plans to address any resource needs are outlined in the action plan. Information and support will be required from various areas of the University in order to implement the plan.

COMPLIANCE WITH POLICY/LEGISLATION:

The Ontario Universities Council on Quality Assurance (Quality Council), established by the Council of Ontario Universities in July 2010, is responsible for oversight of the Quality Assurance Framework processes for Ontario Universities. The Council operates at arm's length from both Ontario's publicly assisted universities and Ontario's government. Under the Quality Assurance Framework, academic programs must undergo a cyclical review at least every eight years following their implementation. The purpose of the cyclical program review is to critically examine the components of a program with the assistance of outside reviewers with the goal of continuous improvement. A program review's purpose is not solely to demonstrate the positive aspects of the program, but also to outline opportunities that will lead to improvements for the future.

NEXT STEPS:

- Following presentation to Academic Council and the Board of Governors for information, the FAR will be sent to the Quality Council as required under the Quality Assurance Framework. A summary report will then be posted on the Ontario Tech corporate website.

SUPPORTING REFERENCE MATERIALS:

- Final Assessment Report
- PLO Enhancement and UDLE Mapping



FINAL ASSESSMENT REPORT
Executive Summary
September 2021
Bachelor of Science, Applied and Industrial Mathematics
Program Review
Dean: Dr. Greg Crawford

Under Ontario Tech University's Quality Assurance Framework, all degree programs are subject to a comprehensive review every eight years to ensure that they continue to meet provincial quality assurance requirements and to support their ongoing rigour and coherence. Program reviews involve several stages, including:

1. A comprehensive and analytical self-study brief developed by members of the program under review.
2. A site visit by academic experts who are external to and arm's length from the program who prepare a report and recommendations on ways that it may be improved based on a review of the program's self-study and supporting material, and a two-day site visit involving discussions with faculty, staff and students and a tour of the facilities.
3. Development of a plan for improvement by the program and proposed timelines for implementation.

On the completion of the program review, the self-study brief together with the reviewers' report and the assessment team's response are reviewed by the Resource committee, the appropriate standing committee of Academic Council (USC/GSC), and are subsequently reported to Academic Council, the Board of Governors and the Quality Council.

In academic years 2017-2019 a program review was scheduled for the Bachelor of Science in Applied and Industrial Mathematics.

This is the second program review for this program and the internal assessment team is to be commended for undertaking this assignment in addition to an already challenging workload and within a very tight timeline. The following pages provide a summary of the outcomes and action plans resulting from the review, identifying the strengths of the program as well as the opportunities for program improvement and enhancement. A report from the program outlining the progress that has been made in implementing the recommendations will also be put forward in eighteen months' time.

External Reviewers:

Dr. Matthew Davison, Western University
Dr. Nilima Nigam, Simon Fraser University

Site Visit: March 8th – 11th, 2021

Program Overview

The Applied and Industrial Mathematics (AIM) program was designed with a specific focus on developing knowledge of mathematics and its relevance in modern applications. This focus distinguishes Ontario Tech's program from many mathematics programs across Canada which give more weight to pure mathematics courses in their curricula. Mathematics underlies many of the technologies we take for granted in modern life. It is a fundamental component within every aspect of scientific endeavour. Mathematics is a key component of problem-solving, from the modelling of atmospheric physics to the complexities of managing risk in financial markets. The AIM program was designed with the intention of providing students with a deeper appreciation of the relevance of mathematics in interpreting the world around them.

Students in the AIM program internalize basic concepts and principles of mathematics in addition to quantitative and qualitative methods of mathematical analysis and state-of-the-art algorithms and software. The goal is to provide a deep scientific foundation in their courses to support innovative problem-solving skills related to current employment areas. Mathematics graduates need relevant advanced numerical skills, including the ability to carry out statistical analysis of data, the ability to construct models of physical or biological phenomena, and the ability to implement algorithms in modern computing environments. These more sophisticated skills are honed in the mathematics courses offered in the upper years of the program.

Students are also encouraged to explore and apply their mathematical knowledge in a different subject area by means of a minor program of study. The structure of the AIM program easily allows students to complete a minor from a selection of disciplines including Physics, Data Science, and Finance.

In addition to the regular Applied and Industrial Mathematics program, students can enroll in a co-operative education option. This five-year program combines the BSc (Hons) program with embedded work terms. The co-op option gives students opportunities to apply classroom concepts to real-world situations and helps them gain valuable, relevant work experience to promote networking and lifelong career success.

Significant Strengths of the Program

- The program is a well-designed honours program in applied mathematics
- The explicit focus on industrial mathematics is a distinguishing feature compared to many other mathematics programs in Canada.
- The current UPD seems to have started excellent retention initiatives and this excellent work is leading to an uptick in enrollment numbers. These include,

the mentorship program, math-mixer events and the Marvelous Math Mondays undergraduate seminar.

- The program has curricular flexibility built in (topics courses in applied math can extend beyond physics/bio/chem with minor tweaks). The flexibility enables the program to incorporate the most relevant current applications without having to go through the program modification process for every adjustment.
- The current students seem to be happy with the program. This is due to the quality and dedication of the faculty.
- In most classes, students are involved in active learning, and in many classes, there is a projects-based/experiential-learning component.
- The instructors are continuously striving to provide the best experience possible for the students.
- Both research and teaching focused faculty are committed to the teaching mission of the program in ways that are not so uniformly true at all universities.
- Students are transferring from other programs in the first couple of years. This is related to the ability of the instructors to engage and inspire the students.
- Cooperative education is a natural fit with the program. The analytical and computational components of the program provide the skills that ensure the students are qualified for a large number of available jobs.
- The program has strong collaboration with other programs in the Faculty of Science, which aids the program in a variety of ways, including through cross-listed courses with Physics, Computer Science, and to a lesser degree, Engineering, which provide a broader perspective to AIM students.

Opportunities for Program Improvement and Enhancement

- Overall enrolment in the AIM program needs improvement. Collaboration with other program has improved course enrolment in key second- and third-year MATH courses, however registration in fourth-year courses, as well as overall enrolment in the Major program, continues to be low. In particular, there is an opportunity for improvement in the program retention between second- and third-year.
- Student participation in the cooperative education opportunities needs improvement. Currently, the cooperative education program it is under subscribed and not well-advertised to the AIM students. There is a great opportunity to add value to the AIM program because the content of the program is well-suited to many of the jobs available to the students.
- A slight broadening of focus of the program to include more topics in statistics, data science or discrete mathematics may be worthwhile. In particular, this may help prepare students better for the current job market, and would likely be well subscribed by students seeking relevant electives.
- Continued improvement in the promotion of the Undergraduate Thesis. In the past few years, the undergraduate thesis has been under-subscribed, but renewed focus of the faculty on the promotion of the thesis option has shown a marked improvement in thesis project applications for the upcoming academic year.

- Enhanced attention to the “Effectively communicate mathematical findings and principles to professionals and the general public” program learning outcome would be beneficial to the program overall. An increase in co-op participation will certainly aid in this respect, as well as the inclusion of presentation and writing skills instruction in appropriate courses.

The External Review

The site visit took place on March 8th – 11th, 2021. Drs. Davison and Nigam met with members of the Faculty as well as key stakeholders at the University, including Dr. Lori Livingston – Provost, Dr. Greg Crawford – Dean, Dr. Greg Lewis – IAT Chair, Prof. Ilona Kletskin – AIM Program Director, and members of the internal assessment team and a number of faculty, staff, and students.

The Faculty was grateful for the thoughtful and thorough review provided. The external reviewers recognized the high quality of the faculty, the rigorousness of the program, and the innovation in the content and delivery of the programs.

The reviewers identified six recommendations, some of which have multiple components. The Faculty values the recommendations and have been very thoughtful in their responses.

Summary of Reviewer Recommendations and Faculty Responses

Recommendation 1 & 6

That a committee be formed to provide direction, support and continuity to the efforts of the UPD. The current UPD-reliant model is not sustainable, especially with the new program (*Integrated Math and Computer Science*) coming on board. A committee which actively helps this portfolio, a clear delineation of responsibilities, and identification of campus resources (e.g. Co-op office, career center, administrative help) to interface with, could substantially and positively impact the program. (Recommendation 1)

The unit, in consultation with the Dean, should review the responsibilities associated with these positions, identify repetitive/administrative tasks, and identify appropriate staffing help within the university to alleviate these pressures. (Recommendation 6)

IAT’s Response to recommendation 1 & 6

We will implement a program committee that will include all group members. The committee will include a number of subcommittees that will be responsible for specific tasks related to the program. The committee will have regular meetings at least once a month, at which any issues regarding the program will be discussed, and updates of the activities of the subcommittees will be provided and discussed. Terms of reference for the program committee and its subcommittees will be formulated. Simultaneously, in reference to Reviewer Recommendation 6, we will review the role of the UPD and realign some of the UPD’s responsibilities in association with those of the new program committee and subcommittees. As recommended by the reviewers,

the roles of the UPD as well as the work of coordinating the lower-division classes will be internally reviewed, in association with the Dean. In particular, tasks of an administrative/clerical nature that are appropriate for staff to handle will be identified.

Possible subcommittees of the program committee include:

- **Recruitment and retention committee**
 - Which will be responsible for organizing and participating in recruitment events such as the open houses and scholar's dinner, as well as retention initiatives such as the mentorship program, undergraduate seminars and 'Math Mixers'.

- **Outreach/Modelling competition committee**
 - Which will participate/organize activities that will enhance exposure of the program to prospective students (e.g. volunteering for the IM2C High School Math Modelling competition); it will also organize participation and training of AIM students for math modelling and other competitions

- **Co-op/careers committee**
 - Which will work with the faculty co-op coordinator to address some of the reviewers' concerns about the co-op program. In particular, this committee will help to identify relevant work opportunities and will advertise these to the students. It will also organize career info sessions.

- **Dissemination/alumni committee**
 - Which will be responsible for maintaining the program web-pages and any other social media, for developing any advertisement of the program, and for maintaining contact with alumni, collecting their stories and presenting these.

Dean's Response to recommendation 1 & 6

The external reviewers identify that too much is expected of the UPD for the equivalent of one course release and recommend that: (a) a committee be formed to support the UPD and the operational needs of the program (Recommendation 1) and (b) the program faculty identify repetitive/administrative tasks undertaken by the UPD (and course coordinators) and appropriate staffing be provided to alleviate those responsibilities (Recommendation 6).

Regarding Recommendation 1, I certainly recognize the assumptions that are often made that a UPD, with one course release, should be responsible for all of the operational needs of a program. I wholeheartedly support the notion of the program faculty establishing a committee to share the responsibility for providing direction for the program and support for the UPD. The IAT has already identified a number of particular areas of interest around which subcommittees may be formed.

As Dean, I am certainly open to considering such committee-related work as a part of faculty members' service. However, I would recommend the faculty members identify the most important areas and focus on those first; there are some areas that may need to be addressed by one or two people each year, but I'm not sure a formal subcommittee will be needed for every area. While exploring ideas is valuable, the goals of these efforts should, obviously, include efficiency and effectiveness.

Regarding Recommendation 6, the focus seems to be on what has been identified as "non-academic workload" associated with the UPD and course coordinator roles. I support the proposed analysis by the faculty of "repetitive/administrative tasks".

In terms of finding ways to offload any of these tasks to administrative staff, I note that our current office staff already all have full workloads. As I look to ways to alleviate some of the administrative burden for the AIM UPD and course coordinators, I will likely need to look to both a reassessment of workload priorities among the administrative staff and to request for additional administrative resources. Furthermore, I suspect at least some of the tasks that will be identified will be similar across Science programs; some may well be different. Certainly, a case for any additional administrative resources would be strengthened if the issues involved more than a single program. Perceptions of fairness across programs would also need to be addressed.

Recommendation 2

Program members identify measures to considerably enhance the exposure of early-year students to research faculty.

IAT's Response to recommendation 2

In the past, we have made an effort to ensure that teaching assignments included a rotation of the research faculty into first-year courses. This ensures not only exposure of the first-year students to the research faculty, but also ensures a variety in the teaching assignments of the teaching-focused faculty. In the past year, we had 2 of four research faculty (one was on research leave) teaching first-year courses. We will continue and enhance this practice, as much as possible, while ensuring that the higher-level courses are appropriately covered.

We also will continue a newly started practice of having all faculty give seminars in the Marvellous Math Monday series, in which the research faculty give a talk about an aspect related to their research that is accessible to all levels of undergraduate students. We will also look for other ways of enhancing exposure of research faculty to first-year students, for example, by having research faculty give guest lectures in the first-year courses. It would be ideal if this guest lecture could be related to faculty research. However, given the quantity of material in the first-year courses, this will likely not be possible.

Dean's Response to recommendation 2

I support the proposal to encourage all AIM faculty to give seminars that would engage first- and second-year students.

Recommendation 3

The unit examine its teaching/service allocations, ensuring that student recruitment is a unit-wide priority. The unit should be given more authority in determining its own teaching assignments.

IAT's Response to recommendation 3

We will formalize recruitment initiatives through the formation of a recruitment and retention subcommittee of the program committee. The Dean already provides us with a fair amount of autonomy in determining teaching and service assignments. The Dean has indicated that he considers service to the program to be important, and will not penalize the faculty for prioritizing service to the program over other service.

Dean's Response to recommendation 3

I support the proposed approach of the AIM faculty focusing attention on recruitment initiatives, although I feel recruitment and retention/student success should be considered different activities.

I also agree that I give a lot of autonomy in determining teaching and service assignments. I would frame my approach to service somewhat differently from what is written above, however. The university, Faculty, and AIM all have needs for faculty service to meet goals (TTT faculty also have responsibilities and needs to serve their disciplines as well). Overall, a blended approach is necessary. I would certainly support AIM faculty, as individuals and as a group, in including service to the AIM program as a part of their overall service. That needs to happen and may well mean a net reduction in their overall contribution to other service areas. However, I would expect AIM faculty, as individuals and as a group, to have their service span more than just the "program domain." I am always open to discussion with the faculty regarding what their overall service looks like for any given year.

Recommendation 4

An expansion of connections with other faculties (Engineering, Business, Education) might be beneficial to and explore the possibility of students receiving credit in the program for relevant courses in other faculties and vice versa.

IAT's Response to recommendation 4

We will look for further ways to enhance our connections with other faculties. Of note is the recent collaboration on a project between faculty members from AIM and the Faculty of Education (project title: Digital Fluency to Support Online Post-Secondary Mathematics Instruction). We will leverage this, and existing relationships with members of other Faculties who participate in the Modelling and Computational

Science Graduate Program (in particular those in Business and IT) to further develop connections.

Students can already receive credit for taking courses in other Faculties; up to 18 credits of their electives can be taken in non-Science courses. However, we agree that taking courses in other faculties can be very beneficial to an Applied Math student. Therefore, we will compile a list of relevant non-Science electives and advertise these to the students

Dean's Response to recommendation 4

I agree with and support the IAT's recommendations.

Recommendation 5

Suggest the unit consider the program be renamed, for instance, "Math for Science and Industry".

IAT's Response to recommendation 5

We will consider changing the name of the program. In particular, we are considering: Mathematics for Modern Applications.

Dean's Response to recommendation 5

There seems to be general agreement among the external reviewers, the AIM faculty, the Dean, and others that the program name is not particularly appealing to prospective undergraduate students. In my opinion, neither of the suggestions made by the externals and by the AIM faculty is any more effective with those prospectives. Understanding the inherent limitations, I believe we need input from recruiters and perhaps others to come up with a name that is more appealing and that we can live with.

As an example, if we just called the program "Mathematics" and generated a little more enrolment, I would argue the program would be in a little better position than it currently is. However, I would still seek input from those who understand high school students' interests better. And the more nuanced information about how this particular program is different and "better" (in our opinion), how it connects to the University of Ontario Institute of Technology Act (e.g., "The objects of the university are, (a) to provide undergraduate and postgraduate university programs with a primary focus on those programs that are innovative and responsive to the individual needs of students and to the market-driven needs of employers") and such can be clarified through narratives and marketing material as necessary.

Additional comments from the IAT to generally address the recommendations:

- We will formalize the broadening of the program focus by introducing new Math elective courses, e.g. Introduction to Graph Theory (discrete mathematics), Mathematics of Machine Learning (data science), and a third-

year topics course, which can maintain the flexibility that the reviewers recognized as a strength of the program.

- We will also include specific presentation and writing skills instruction in our classes (e.g. making room in a course for an hour-long presentation skills workshop provided by the Student Learning Centre).
- We will vigorously promote the undergraduate thesis and its benefits to all students, regardless of their career goals.

Plan of Action

The table below presents a timeline of the actions planned to address the recommendations from the external report.

Recommendation	Proposed Follow-Up	Responsibility for Leading Follow Up*	Timeline	Resources/Support Needed
<p>Recommendations 1 & 6:</p> <p>Establish a committee to provide direction, support and continuity to the efforts of the UPD. the program. (Recommendation 1)</p> <p>Review the responsibilities associated with UPD and course coordinator roles, identify repetitive/ administrative tasks, and identify appropriate staffing help within the university to alleviate these pressures. (Recommendation 6)</p>	a. Review of UPD and course coordinator roles	AIM UPD AIM course coordinators Dean	Dec. 2021: faculty complete review and share with Dean	N/A
		Dean DPO	Feb. 2022: Dean and DPO determine the potential for AIM admin support	Potential resource reallocation within Science
		Dean Other UPDs Other course coordinators	Mar. 2022: If necessary, Dean surveys other faculties	N/A
		Dean DPO	Sept. 2022: If necessary, Dean prepares admin support budget request	Potential admin resource budget request
	b. Formation of program faculty committee	AIM faculty	Jan. 2022: faculty committee formed	N/A

Recommendation 2: Identify measures to considerably enhance the exposure of early-year students to research faculty.	Improve exposure of 1 st and 2 nd year students to research faculty	AIM faculty	Fall 2021 semester: begin inviting all faculty to give seminars as part of Marvellous Math Monday seminar series.	N/A
Recommendation 3a): Examine teaching/service allocations, ensuring that student recruitment is a unit-wide priority.	AIM faculty re-examine teaching/service, ensuring student recruitment is a unit-wide priority	AIM faculty	April 2022: faculty committee [see response to Rec. 1] reviews its overall teaching / service priorities, to include student recruitment as a unit-wide priority; recommendations made to the Dean	N/A
Recommendation 4: Explore and expand upon connections with other faculties (Engineering, Business, Education).	a. Explore potential connections to other Faculties	AIM faculty	April 2022: review efforts to develop deeper connections over the past year	N/A
	b. Identify courses in other Faculties of potential value to AIM students	AIM faculty	April 2022: Develop list of relevant non-Science electives and make it available to AIM majors	N/A
Recommendation 5: Consider the program be renamed, for instance, "Math for Science and Industry".	Review options for changing program name and determine if a change is warranted	AIM faculty Dean Recruiting Office	April 2022: determine if a program name change is warranted and, if so, what that change would be; submit appropriate paperwork	N/A

*The Dean of the Faculty, in consultation with the Program Review Chair shall be responsible for monitoring the Implementation Plan. The details of progress made will be presented to the Academic Resource Committee, Academic Council and the Board of Governors and filed in the Office of the Provost and Vice-President (Academic).

Recommendations not Addressed

Recommendations not addressed and rationale from the Deacanal response.

Recommendation not Addressed	Rationale
Recommendation 3 b): AIM faculty unit should be given more authority in determining its own assignments	The AIM faculty already have a lot of authority in determining teaching and service workloads (although, as discussed above, more work will be done by the faculty to coordinate service to the program)

Due Date for 18-Month Follow-up on Plan of Action: March 2023

Date of Next Cyclical Review: 2025-2027



Cyclical Program Review: Summary of program learning outcome enhancements

[This form should be used in cases where program learning outcomes have been enhanced for an existing undergraduate or graduate program. These updated program learning outcomes should be the result of a program review and have been developed with guidance from CIQE. This form will be appended to the Final Assessment Report]

Faculty: Science	
Program: Applied and Industrial Mathematics	
Review year: 17-19	
Undergraduate: X	Graduate: <input type="checkbox"/>

Original program learning outcome(s): (Provide all of the initial program learning outcomes)

- Apply knowledge and understanding of the basic concepts, theories, and principles of mathematics and the related physical and biological sciences to theoretical and practical problems in these areas.
- Explore the current state of knowledge in mathematics and investigate innovative solutions to significant related scientific problems.
- Utilize knowledge to analyze, evaluate, and apply the concepts, techniques or processes needed in the study and application of mathematics.
- Communicate effectively in written, spoken and visual format with both technical experts and members of the general public on science issues.
- Understand and utilize contemporary laboratory and measurement techniques, procedures, safety protocols and equipment necessary for conduct of work in physical science.
- Plan and implement experiments and investigations, critically examine the results and draw valid conclusions
- Apply to scientific study, an appreciation for the level of uncertainty in experimental results and theoretical predictions
- Apply relevant numerical skills including statistical analysis as necessary for physical sciences
- Use current Information Technology to access, store and retrieve information, to acquire and process data, and to analyze and solve problems
- Contribute as effective participant in multidisciplinary and multi-cultural teams, in both membership and leadership roles.
- Recognize and value the alternative outlooks that people from various social, ethnic and religious backgrounds may bring to scientific endeavours
- Have well-developed strategies to update knowledge, maintain and enhance learning.

Total number of original outcomes: 12

Proposed enhanced learning outcomes: (Updated outcomes as a result of the program review learning outcome workshops)

- Demonstrate an understanding of fundamental mathematical principles and techniques.
- Use critical thinking and analytical skills to identify and articulate mathematical problems.
- Effectively communicate mathematical findings and principles to professionals and the general public.
- Identify their current level of understanding in mathematics, and acquire new knowledge independently.
- Apply mathematical principles and skills to multidisciplinary problems, and leverage these skills when working with interdisciplinary teams.
- Demonstrate an ability to adopt evolving technology and computing, including the employment of programming languages and relevant software.
- Evaluate and critically examine available experimental and statistical data to draw valid conclusions.
- Practice scholarly pursuits and professional endeavors that contribute towards the growth of mathematics, with an appreciation of the integrity and ethics of its applications.

Total number of enhanced outcomes: 8

Have the enhanced outcomes been mapped to the degree-level expectations (DLEs)?

Yes No

If no, this should be completed no later than:

Are you providing any additional supporting documents? Yes No

If yes, which (list all)?

The UDLE alignment map can be provided upon request.

CIQE INTERNAL APPROVAL

Appended to FAR	
FAR approved by USC/GSC	

Final Approved FAR & Outcomes Posted and sent to Faculty	
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