SAMPLE 1

FACULTY DEVELOPMENT PLAN

Associate Professor of Manufacturing Engineering

New Faculty Series – February 2024

This document describes my development plan for 2024 as a young Faculty member in the Department of Manufacturing Engineering at BYU. It includes self-assessment, reflections, long-term and short-term goals in the three categories of development: scholarship, teaching, and citizenship. The objective of this plan is to develop further and strengthen an appropriate vision on how to contribute effectively to the mission of BYU, of the College of Engineering, and of the Department of Manufacturing Engineering. It is also to set the priorities for the efforts towards excellence, and to guide my efforts in preparation for the third-year review.

SCHOLARSHIP SELF-ASSESSMENT

Research interests

My research interest is in Microengineering, the "science of miniaturization", searching to increase the ratio between the number of functions over a finite volume in a product or a system. To achieve this, design and manufacturing needs to be considered together. New manufacturing process opens the way for embedding new functions. My research focuses on additive manufacturing of microsystems and medical devices (including sensors, biosensors, microfluidic systems, Internet of things, energy harvesting, micro-batteries, as well as open-source and sustainable electronic products). My research methodology includes microsystems design with analytical or numerical models when appropriate, printing-based manufacturing process development, innovative measuring methods, and characterization with high precision instruments. My motivation is multiple and is related to the fact that manufacturing is key for the economic development of nations and the well-being of its citizens. It includes the potential through additive manufacturing processes, of lowering the needed investments for low series production and of widely democratizing production, starting with the distribution of "low-profit" – "high impact" products, to possibly be extended to production, maintenance, and repair of sustainable consumer products.

Scholarship strengths

I have solid research experience in Microengineering developed along my career with academic and industrial positions. In the 6 years prior joining BYU, I did obtain 12 applied research projects funded for a total of more than CHF 2'000'000.- (~ USD 2,000,000.00). I also have a rich research experience in Microsystems or MEMS, in sensor technology, in miniaturization, in measuring methods, in classical manufacturing, in micromachining, in electronic circuits, in medical devices, in 2D additive manufacturing, and in product design. I love collaborative multidisciplinary research and I find BYU an ideal place to develop unique collaborative works and excel in scholarship. I do speak fluently French, English and German, which helps for academic or professional collaborations, including partners especially from Europe. I do maintain and develop further international academic collaborations coming from my former faculty position in Switzerland, which is stimulating. To develop my research lab, we ordered and received a unique new pad printing machine allowing multilayer printing, with fast drying capabilities. With this new equipment, new projects are now possible in collaboration with undergraduate, graduate students, and other Faculty members from my department or from other departments at BYU.

Scholarship areas of improvement

As a young Faculty member in the Department of Manufacturing in a topic new for the department, my priority is on pursuing the development of a research lab at BYU with the additional needed instruments, products, and equipment. This will bring the organization of the lab space for 2D additive manufacturing to a more efficient level and promote further the development of the microengineering side of Manufacturing Engineering. Being still new in Utah and USA, I still need to develop my academic and professional network here. For me, 2024 is the year to initiate and develop such contacts and collaborations.

Progress to date

I have hired two graduate students (Jonah Brooks and Elizabeth Clark) who are preparing to develop their thesis projects using the new pad printing machine and optimizing the process. This machine prints 3 μm structured layers of inks with high precision. It is based on an existing multicolor pad printing machine. It has been modified for our purpose to print microsystems efficiently with few distortions. The machine has been fabricated in Switzerland, inspected there on June 23rd, shipped by airplane, delivered late August to BYU in Provo. It has been installed with electrical and fluidic connections and could be started in the middle of November 2023. A lab space has been defined to house the pad printing machine. In collaboration with these two graduate students, various efforts have been undertaken and are in preparation for obtaining funding to develop new research projects in line with these interests.

I took advantage of many events organized by the Research Development Office aimed at promoting networking between Faculty members, learning about the support to be found at BYU for research development, and at improving our grant writing skills. I did submit a first stage version of a grant proposal entitled "Open-source experimental benches enhanced learning outcomes in manufacturing engineering education" to the Department of Defense to respond to a call of Project on Manufacturing Engineering Education, but it did not get invited for the second stage. It was in collaboration with Dr. Quentin Allen from my department. Then, following the Call from the BYU Research Development Office (RDO) on IDR Special Topic Cancer Research, a proposal entitled "Development of a simple antibody test biosensing method for gastrointestinal cancer-derived exosomal biomarkers quantification" in collaboration with Dr Amber Gonda from the Department of Cell Biology and Physiology, has been submitted. We did receive early February that it was not accepted to be funded at this time. It needs revision and should be resubmitted in April. Another project proposal to be entitled "OpenInjectAid: An open-source injection aid for higher accessibility to emergency drugs" is in preparation. This is a proposal in collaboration with Dr Chantel Sloan, who is currently on maternity leave, from the Department of Public Health at BYU, and with Dr. Philippe Eigenmann, from the University of Geneva and Geneva University Hospital.

TEACHING SELF-ASSESSMENT

Teaching philosophy

My guiding principle for teaching is to lead the students through a series of theoretical content and experiences in a constructive and professional environment. The Gospel principles are a valuable guide for me to set a proper learning environment with benevolent mutual relations. I do understand the role of professor regarding the learning process of students, to be like a guide pulling the student with a wool thread in the right direction. If no pull action is given, no direction is given. If too intense a pull, the wool thread may break, losing the possibility to guide the student.

I do consider as important for the student to relate the learnings with his future position as engineer in the industry. Therefore, I search to use real life examples (i.e., from my own experience) of why the learnings are important, and how they can play a role in the industry or in the academy. Moreover, I seek to transmit through the chosen teaching methods, that not only knowledge is important for future employers, but also practical know-how, as well as know-how-to-be, and how-to-act. I do strive to stimulate students to be challenging regarding their level of understanding of the taught topics.

Teaching strengths

At the beginning of my career as a Faculty in Switzerland, I did a basic didactic training with follow-ups in a program of continuous teaching education. I did consequently acquire an extensive teaching experience at the University of Applied Sciences Western Switzerland (undergraduate and graduate level). Interestingly such universities are known for their practical teaching method approaches. The courses I did teach in the microengineering and industrial technologies study courses, included topics in micromachining, in quality testing, in assembly, in miniaturization, in sensors, in actuators, in energy harvesting, in measurement and in product design methodologies, as well as in 2D additive fabrication techniques. I also taught graduate students from the University of Geneva in Switzerland.

I taught the MFGEN-318 (old IT-C-318) course in the Winter 2023 semester with good students' rating (4.6) and useful feedback. I coached a Capstone team as well through the academic year 2022-2023, with successful completion of the project by the students. The students' ratings (4.3 FS and 4.4 WS) were good. Useful or interesting feedback was given. In Fall 2023, I did teach the MFGEN 401 course on Data Analysis to 41 students, with students' rating at 4.1, and with also useful comments. This was for me also the opportunity to deepen and refresh my knowledge in Data Analysis, a topic key for the department and very useful for my research. In Fall 2023, I did also start to coach a Capstone team with students' rating at 5.0.

Teaching areas of improvements

For my MFGEN 318 course, the areas of improvement include the organization of a good lab environment with the needed instruments for learning Electronics. This could be mostly done in early February 2024. Also, for this class I am better structuring the learning activities outside the class, as well as the use of Learning Suite, especially to the communication of the grading strategy. I am also striving to strengthen the character-building aspect of the student education. For my MFGEN 401 course, the areas of improvement include an improvement of the existing slide, an update on some software aspects of the course (replacing VBA coding by up-to-date solutions). In general, teaching at BYU and searching to spiritually strengthen the students in an engineering class, is still new to me, and can certainly be improved.

Progress to date

I participated in all pre-CFS seminars for new Faculty, which included many teaching aspects as well general as specific at BYU. I participated in the Effective Teaching Principles Through a Gospel Lens Workshop held throughout the week of July 10, 2023. I have regular meetings with my mentor (Dr. Michel Miles) who guides me also in my teaching tasks and questions. I do participate in the teaching training events organized by the College of Engineering. I do search to include inspiring quotes in my lectures that can possibly be related to the topic of the day. In general, I do strive to bring the spiritually inspiring aspects in with my students through my example, searching for being kind, fair, accessible, respectful, right with all students, and a very good to excellent teacher.

CITIZENSHIP SELF-ASSESSMENT

Citizenship strengths

I participated in my previous position in numerous efforts building community through collaboration for research, for teaching purposes or for the public. I am rather generous in my sharing of time and ideas that could lead to the development of the other person, or of the public interest. As a person quite open by nature, I do easily talk with new people, discuss new ideas, while being sensitive to their needs. In my department I do participate in two committees. I do informal student mentoring. I am sensitive to welcome prospective students. I do participate and contribute to the effort from colleagues to work together (e.g. writing group, bioengineering grand rounds).

Citizenship areas of improvements

Being quite new in the country, my academic network outside BYU is emerging and needs to be developed. My post-doctoral experience in Maryland more than 20 years ago helped me to have some experience with the federal funding agencies. Though I need to find and join a review committee, to serve and to learn more about these agencies. Similarly with conferences, which do exist in high numbers, I need to select one or two of them here in the USA and develop contributions to them. Being active in an academic where multidisciplinary is essential, being creative, and not afraid to take initiatives or responsibilities, I need to be careful with the management of my time, and in the setting of my priorities. I also need to strive to delegate tasks that are less important and less urgent.

Progress to date

I do participate in the Writing Club at the level of the College of Engineering organized by Dr Munro. This club allows the sharing of research written materials for mutual review, feedback, and discussions. I do participate in the Biomechanics and Bioengineering Grand Rounds when organized by Dr. Bowden. I am a member of the Graduate Committee, and of the Undergraduate & curriculum Committee in my department. I do occasionally review of journal articles per year (1 every 2 months), currently mainly for the Swiss based MDPI publisher. But I plan to increase my rate of reviewing approximately one paper per month, for several of the good journals in my field. I do receive and discuss regularly with students or prospective students interested in Manufacturing Engineering, in my courses, or in my research area. I did join (back) two societies from the Institute of Electrical and Electronical Engineering (IEEE), plus one of their groups of interest. I also did offer my service as panel reviewer to a NSF program manager.

LONG-TERM GOALS

My first objective is to flourish as BYU faculty and reach the level of performance in all the expected domains to be confirmed in continuous status and to be a recognized leader in my academic domain. To reach this objective I did develop the following long-term and short-term goals (see in this and in the next section).

Scholarship

My long-term goal is to contribute to the vision of a sustainable industry in a large sense, more impact than profit driven (i.e. for industrial and health applications), having:

- complementary manufacturing approaches appropriate for the needed life cycle of a given product and optimized for upgradability, repairability, or recyclability in an efficient manner,

- conventional centralized manufactures for highly demanding processes or rather large series, and decentralized or regional manufactures spread worldwide with suitable production means for less demanding processes, for very small to medium series and for consumables,
- a growing number of products with the open-source hardware rationale for decentralized manufacturability.

Considering 2D and 3D additive manufacturing processes as key factors for the development of a sustainable industry, for this purpose my primary academic interests focus on:

- Pad printing as a 2D additive manufacturing process,
- Design and Manufacturing of "low-cost" Microsystems
- Open-source manufacturing

Teaching

My long-term goal in teaching is excellence in all its aspects, keeping up to date the contents of the needed undergraduate and graduate courses in the field, as well as my teaching methodology.

To mentor PhD students.

To study the pertinence, and feasibility of organizing, or of participating in a study abroad on Manufacturing Engineering, and to contribute to its teaching.

Use ABET methodology to assess and improve learning outcomes for my courses.

Citizenship

At the international, national, and state level, keep and develop further a strong network of research partners, and participate in an organizing committee of one or two research conferences.

At the national level, contribute to a reviewing committee from a federal research agency compatible with my research activity.

At the Utah level, join a professional society that could benefit from my contribution.

At the BYU level, contribute to the various citizenship activities reinforcing the students, and the mission of my department.

SHORT-TERM GOALS FOR 2024

Scholarship

To keep my scholarship development at BYU, where the Gospel is part of the reality we can embrace as researchers, and where the mission is of most importance, I intend for 2024 to reach the following goals:

- Keeping a daily rhythm of doing at least 15 minutes writing (grant proposal or paper) and 15 minutes reading and making a half day per week exclusively reserved for uninterrupted scholarship work.
- Documenting my scholarship efforts in my scholarship logbook, to include the time spent on writing and reading, plus including the goal for the next day, and using this document for self-assessment of progress or for discussions with my mentor.
- Use, keep, and update when needed a research plan with the list of detailed ideas, activities, resources, and priorities to reach the scholarship goals.
- Having the logistic of my research space to an acceptable to very good organization level to stimulate quality work for my graduate students, me, or other faculties from the department.

- Submitting at least two new articles for publication in quality peer-reviewed journals, starting publishing with my graduate students, and contributing to a high-quality conference.
- Submitting grant proposals for $500K or more, mainly from external funding sources.
- Volunteer to sit on an NSF review panel or equivalent this year.

Teaching

Keep track of my thoughts, analysis, and actions regarding teaching in a teaching journal (doc file at the time, and online when online journal is available and fully functional).

Develop a graduate course at 5xx level for 2024, to possibly evolve later in a 6xx course.

MFGEN 310 Manufacturing Electronics and Microsystems

Teach successfully the second edition of the MFGEN-318 course (Manufacturing Electronics and Microsystems) in the Winter semester 2024 applying the decided corrective and monitoring measures following the analysis of the student's assessments information (as described in the teaching journal), namely:

What: Improve the course organization.

How: By providing from the beginning the detailed program of the semester, especially the information of the planned grading system, and the assigned readings as well as the homework.

What: Monitor the next student's evaluation the number of hours spent per week out of class per credit hour (in WS 2023: 1.11 hours, ideally: 2 hours).

What: Monitor the next student's evaluation the feedback on character building.

What: Monitor the next student's evaluation the feedback on spiritual strengthening.

MFGEN 401 Data Analysis:

After the first time teaching this course, my main objective of evolution for this course is to increase its applicability to manufacturing and to process development. This course, composed purely of classes with no labs, will need to benefit from examples generated in the department during other activities. It seems also that more elements to make the course more spiritually enlarging are expected. This will also be taken as a goal for the next edition.
More specifically my goals for the next edition are:

- Enhance the newly introduced M&M's class activity on basic concepts of statistics.
  Method: In addition to statistical sampling, and hypothesis test on colors, include the precise weight measurements to exercise additional concepts (mean, median, standard deviations, additional hypothesis, …). A special budget is being asked through the NFS series potentially offering $500.00 for such activities.
- Improve the organization of the project.
  Method: The end-of-semester projects were planned and conducted as individual projects. This led to 41 presentations of 7 minutes on projects having topics ranging from 3D printing quality to gingerbread stiffness study. The student could much benefit, to my point-of-view, of working as a 2-3 student group to deepen each study, to focus it more on a manufacturing topic, and to have more time to report and present.
- Introduce a final exam and adjust accordingly activity grade weights.
  Method: There was no final exam. The final project presentation took the place of the finals. The student attendance at the end of the semester decreased related to this situation. Also, the last topics in the program were more descriptive learnings of software (Access from Microsoft, PowerBI), than learning of higher level according to the Bloom taxonomy. The course could

benefit from having a real final exam, with less descriptive chapters at the end of the semester. Also, the weight of each work could be reorganized as such: 20% homework, 20% quiz 1, 20% quiz 2, 20% project, 20% final exam.

- Improve spiritual strengthening.
  Method: By being more intentional, bringing ethical issues to be discussed in class, when possible related to statistics.

Citizenship

At the University level, my citizenship goals for 2024 are:

i. Developing collaborative teaching.

- Keep participating in the training, and in the other activities from the College, or University, as well as in the teaching efforts of colleagues.

ii. Developing collaborative scholarship.

- Keep developing scholarship collaborations with other BYU Faculty for the development of new ideas, project proposals or journal articles.

iii. Building Collegiality.

- Keep participating actively the meetings, retreat, other events from the Department, to strengthen me, to develop further excellence, collaboration, and to apply more intentionally Gospel methodology in my teaching and scholarship efforts.

At the professional level, these goals for 2024 are:

iv. Strengthening my current action building professional citizenship.

- Keep increasing the number of reviews of journal articles or project proposals to one per month and diversify the publishers.
- Develop further a strong research network of research partners at the international, national, and state levels to make citizenship contributions (e.g. joining a reviewing committee from a federal agency, initiating new contributions to a professional society).

To reach these citizenship goals, I will pursue the activities already started and add the new ones listed in the teaching and scholarship reports, which have a citizenship dimension.

TEACHING DEVELOPMENT PROJECT— FINAL REPORT

Associate Professor of Manufacturing Engineering

February 2024

This document presents my final report of my teaching development project after having taught for the first time last semester (Fall 2023) the MFGEN-401 course on Data Analysis. It includes my analysis of the student learning, the learning environment and of the process of improvement. Specific goals for the second time I will teach this course are also included. My main objective was to take over this lecture taught by another faculty, and to start integrating elements from my own professional experience, and my own research projects.

STUDENT LEARNING

The course information with its detailed schedule and the university statements was communicated to the students before the beginning of the course through the syllabus published on Learning Suite, and orally during the first class of the semester.

Learning outcomes

The learning outcomes of this course are:

- **Statistics & Data Analysis Tools:** Students will be able to select and apply an appropriate statistical method in manufacturing engineering to summarize data in a meaningful way or to make predictions from a dataset. For this purpose, students will understand the roles of descriptive & inferential statistics in manufacturing and demonstrate the ability to collect and analyze data according to statistical best practices. *Links to Program Outcome: "New Knowledge".*
- **Design of Experiments:** Students will be able to design experiments to be run for the optimization of a multifactorial dependent manufacturing process, analyze the resulting data, evaluate the influence of each parameter, and make recommendations for optimal manufacturing parameters. For this purpose, students will understand the advantages of controlled factorial experiments and demonstrate the ability to set up and draw conclusions from factorial experiments. *Links to Program Outcome: "Experimentation".*
- **Regression Analysis:** Students will deepen their understanding and their ability to use in a relevant manner ANOVA, simple and multiple linear regression, and model fit assessment tools. *Links to Program Outcome: "Experimentation".*
- **Semester Project:** Students will apply data analysis best practices to an open-ended engineering problem and professionally communicate the experiment, analysis, and recommendations. *Links to Program Outcome: "Communication".*

These learning outcomes seek to meet the requirements set by the Accreditation Board of Engineering and Technology (ABET) and the recommendations of the Department Advisory Board.

Learning Activities

The course is organized in a progressive and logical manner seeking to introduce and then to consolidate the various topics. The learning activities include class lectures with examples and exercises, discussions, homework, software coding, tests, project, and student presentations. The variety of activities was helpful for the student to become familiar with complex concepts needed in Manufacturing Engineering. The exercises, the examples, and the project contributed to provide a focus on Manufacturing Engineering. It

was found during the semester that some learning activities needed to be updated. I also felt that a stronger focus on Manufacturing Engineering applications is possible and would be helpful. I will strive to increase this focus the next time I do teach this class, and to do the needed updates in tools employed. A grant proposal to develop this aspect of the course has been written for this purpose.

Learning Assessment

The assessment in this course includes weekly homework, three tests, and a final individual project where each student was using the learned concepts to perform a design of experiment with accompanying analysis and recommendations. After this first semester, I feel that need to reorganize the learning assessment by changing the manner the project activity is designed to allow deeper analysis, and by introducing a final exam as culminating assessment. I plan to introduce this evolution this coming fall.

LEARNING ENVIRONMENT

Relationships

During the semester I strived to develop a good learning environment, being attentive to the need of the students, to cultivate respect, participation, inclusion, and to stimulate the students. Some gospel insights related to data and to ethical issues were included. It appears that more insights and gospel-oriented topics related to the course would be welcome by the students. I will strive to develop further this inspiring element of the course and be more intentional in this effort.

Settings

The initial classroom planned for this course was CTB 340, which is a small classroom with limited spaces for students to work on their computer, to access their place to give assistance with my teaching assistants when needed. To avoid these limitations another classroom (B66 120) could be found before the beginning of the semester. This was quite helpful for interactions between students, and with the instructor or assistants. I searched to create an atmosphere where students could be participating and could feel they could ask questions, share ideas and concerns. One student was announced with special needs for learning and assessments. The needed care was taken to meet these needs.

Materials and Other Resources

There is no textbook for this class. The learning materials available for this class and prepared by the former Faculty member teaching this course, included slides, examples and homework using Excel or other software files (available through Learning Suites), and for selected topics additional or complementing learning published content (text and videos). The use of Excel is recommended by the department Advisory Board for this class since it is widely used in industry. This Board also recommended the replacement of VBA with more modern tools like Python, and as complement tools allowing the management of large quantities of data like Power Query. The fact that VBA was still in the program, and that Microsoft did announce its retirement during the semester, gave the students the impression that this part of the course was outdated. Nevertheless, the examples and homework were quite useful to understand the notions not always clear from the slides. The goal for next year is to remove VBA, introduce Python for statistical calculation as well as Power Query more design for managing large amount of data. To make a first step in this direction, Python was briefly introduced at the end of the semester.

PROCESS OF IMPROVEMENT

Course improvement

To obtain feedback on the teaching of this course, and on my performance as a teacher for this topic, I could benefit of the visit of a colleague for peer evaluation, I also had discussion with my teaching

assistant to obtain valuable feedback, I did study the course assessment organized by the university, and I did complete my teaching journal for this course. This helped me to set the priority for the evolution of this course and of my teaching.

Professional Development

I seek constantly to seize all opportunities offered by the University for new Faculties, and by the College of Engineering to further educate and perfect myself as a teacher. The topic of Data Analysis is a fascinating topic that gain rapidly in significance nowadays, especially for its potential to develop and optimize manufacturing processes I new ways. During this last Fall semester, I took the needed time to complete my professional development with the existing literature available learning materials, to have a better understanding of statistics for Data Analysis. The use of these methods in my research projects is contributing to this professional development.

GOALS FOR THE NEXT EDITION

In general, my main objective of evolution for this course is to increase its applicability to manufacturing and to process development. This course, composed purely of classes with no labs, will need to benefit from examples generated in the department during other activities. It seems also that more elements to make the course more spiritually enlarging are expected. This will also be taken as a goal for the next edition.

More specifically my goals for the next edition are:

- Enhance the newly introduced M&M's class activity on basic concepts of statistics.
  Method: In addition to statistical sampling, and hypothesis test on colors, include the precise weight measurements to exercise additional concepts (mean, median, standard deviations, additional hypothesis, …). A special budget is being asked through the NFS series potentially offering $500.00 for such activities.
- Improve the organization of the project.
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- Introduce a final exam and adjust accordingly activity grade weights.
  Method: There was no final exam. The final project presentation took the place of the finals. The student attendance at the end of the semester decreased related to this situation. Also, the last topics in the program were more descriptive learnings of software (Access from Microsoft, PowerBI), than learning of higher level according to the Bloom taxonomy. The course could benefit from having a real final exam, with less descriptive chapters at the end of the semester. Also, the weight of each work could be reorganized as such: 20% homework, 20% quiz 1, 20% quiz 2, 20% project, 20% final exam.
- Improve spiritual strengthening.
  Method: By being more intentional, bringing ethical issues to be discussed in class, when possible related to statistics.

COURSE DEVELOPMENT GRANT PROPOSAL

Associate Professor of Manufacturing Engineering

New Faculty Series - February 2024

This document describes my proposal for a course development grant aimed at enriching the learning activities of the MFGEN 401 Data Analysis course during my second teaching semester of this class. I intend to use the funds to purchase equipment to improve the quality of statistical concept learning.

DESCRIPTION AND AIM FOR THE USE OF REQUESTED FUNDS

To improve the introduction to data and the analysis of data, I did introduce a learning activity based on studying the content of various M&M's packages. The important notions to be learned through a stimulating activity included the concepts of field of statistics, type of study, sampling methods population size, significance level as well as Hypothesis Testing. To develop further the quality of this activity and the concept of Hypothesis Testing, additional valuable data on the manufactured candies are needed (i.e. the precise weight of each candy). This will allow their detailed analysis (e.g. depending on the type of candy, or on their color), I wish therefore to purchase several scales with 1 mg resolution. The current price of these precision lab scales will allow us with a budget of $500.00 to have in total 4 to 5 scales, making it possible to form groups and have them generate in a short timeframe a sufficient quantity of data that they will be able to analyze, compare and discuss.

The availability of these scales will also open the way to other learning activities in this class to learn the concept of Design of Experiments, or in the labs of my other class MFGE 318 on Manufacturing Electronics and Microsystems.

SCHOLARSHIP DEVELOMENT PROJECT – FINAL REPORT

Associate Professor of Manufacturing Engineering

February 2024

This document presents my scholarship work and accomplishments after 16 months as a faculty member at BYU. I include my evaluation and thoughts regarding the goals, the targeted strategies to enhance scholarly productivity, and the planned evaluation methods, as they were intended in the faculty development plan for 2023, and as I intend to pursue them for my future productivity.

SCHOLARLY ACTIVITIES AND GOALS

My goals for scholarship development in 2023 were:

- Keep regular track of my scholarship efforts in a scholarship logbook ("My scholarship logbook.mm" – Freeplan mindmap software).
- Use and keep the research plan in the file "2023 Research Plan PPA.docx" (see details in the Faculty Development Plan).
- By the end of 2023 and as detailed in the Faculty Development Plan, the goal is to submit two articles for publication in quality peer-reviewed journals. It is also to prioritize and possibly set target deadlines for other papers listed therein.
- By the end of 2023, the goal is to submit one new project proposal. It is also to prioritize and possibly set target deadlines for the other project ideas listed.

I successfully kept track and documented my scholarship efforts, as well as use and update a research plan as decided in the first two elements of the list. The third goal has not been fully met: only one article submitted. A 26-page long article entitled "*Pad-printing of carbon electrodes with argon plasma activation as a simple and low temperature manufacturing process for antibody-type biosensors*" was written and submitted in December to a high impact factor journal: small methods from Wiley. After discussion with my mentor, I decided to put more effort in the preparation of this 26-page long article, with the purpose to aim it for a high impact journal (12.4) to get possibly valuable reviews, and also to have a detailed article as a foundation for the development of my future work at BYU. This decision delayed the writing and submission of the second planned article for 2023. Another article from a previous collaboration with a Belgian medical team was though prepared in 2023 and submitted beginning of 2024. The fourth goal has been met. Two project proposals were prepared and submitted: one to the Department of Defense (DoD) on Manufacturing, entitled "Open-source experimental benches enhanced learning outcomes in manufacturing engineering education", the second one following the Call from the BYU Research Development Office (RDO) on IDR Special Topic Cancer Research. The proposal is entitled "Development of a simple antibody test biosensing method for gastrointestinal cancer-derived exosomal biomarkers quantification". It is in collaboration with Dr. Amber Gonda from Life Sciences, and with Dr. Vaia Florou from the Huntsman Cancer Institute.

EXPERIENCE WITH PRODUCTIVITY STRATEGIES

To focus my efforts seeking a best possible scholarship activity, I decided to apply the following strategies:

- to daily do 15 minutes writing (grant proposal or paper) and 15 minutes research, and document the effort to discuss with coach supervising,
- to seek informal feedback from non-experts, little experts, and capital E Experts.

- focusing on my mission statement,
- keeping goals SMART,
- setting priorities and putting first things first,
- keeping work plans, making choices and being accountable to supervising coach.

I could successfully apply most of these strategies, and this was quite helpful. However, I feel that I need to add to this strategy "reserving a longer time weekly in my calendar without any perturbation in the office and in the lab space" (now that the pad-printing machine is here) to perform the tasks and reflections needing that uninterrupted time. This will also help to reach a higher level of organization in the new lab space to fully use the equipment, create a more efficient and safer research environment (e.g. access to a fume hood for cleaning or use of chemicals), and to better develop projects.

EXPERIENCE WITH THE PLANNED EVALUATION METHODS

To introduce a systematic evaluation method of my scholarship activities, I decided in August 2023 the following:

- Keep regular meetings with supervising coach to present and discuss achievements as well as strategies.
- In the middle of the year evaluate progress towards yearly goals and update, if necessary, the plan on how to achieve them.
- At the end of the year, evaluate, discuss results, goals, and improvements with Faculty mentor and department chair.
- Search for objective research impact factor and monitor progress.

Now about half a year later, there was enough time to evaluate the first point, which was successfully kept. For the second, it is still too early. It will be done during the Spring semester. The third point is part of the regular annual stewardship evaluation. For the fourth point, I learned about several impact factors from different valuable sources (e.g. Google scholar, ResearchGate). I will also use such tools to assess my progress from such sources of possible good report.

RESTATED THEMES, TOPICS, METHODS, AND APPLICATIONS

My research interest is in Microengineering, the "science of miniaturization", searching to increase the ratio between the number of functions over a finite volume in a product or a system. To achieve this, design and manufacturing needs to be considered together. New manufacturing process opens the way for embedding new functions. My research focuses on additive manufacturing of microsystems and medical devices (including sensors, biosensors, microfluidic systems, Internet of things, energy harvesting, micro-batteries, as well as open-source and sustainable electronic products). My research methodology includes microsystems design with analytical or numerical models when appropriate, printing-based manufacturing process development, innovative measuring methods, and characterization with high precision instruments. My motivation is multiple and is related to the fact that manufacturing is key for the economic development of nations and the well-being of its citizens. It includes the potential through additive manufacturing processes, of lowering the needed investments for low series production and of widely democratizing production, starting with the distribution of "low-profit" – "high impact" products, to possibly be extended to production, maintenance, and repair of sustainable consumer products.

Pad printing as a 2D additive manufacturing process

Pad printing is a manufacturing process using sophisticated printing machines generally for the marking industry. With modified inks, it is possible to print structured layers directly on top of substrates of many different materials and shapes. The resolution and quality of the lines or patterns to be printed are limited

by various parameters, including ink viscosity or composition, pad, cliché, machine programming, design. To obtain very good printing results, a lot of know-how is necessary. This know-how is based on empirical observations. We aim to study with a scientific approach the parameters allowing us to obtain optimal printing quality for each targeted function (electrical, magnetic, mechanical, fluidic, …). For this we plan to use various possible methods, design of experiments, development of models (analytical or numerical – FEM – models). Mastering the quality of printing of single layers will open the way to fine control of multilayers printed patterns. Using the appropriate inks, design and manufacturing process parameters, unique devices will be possible (e.g. microbatteries, energy harvesting, wireless sensors, thin electronic circuits).

Design and Manufacturing of "low-cost" Microsystems

To stimulate the development of 2D additive manufacturing processes and to demonstrate its performance, new microsystems can be created. An example currently developed is for biosensing. Biosensors are promising key components for the development of point-of care instruments allowing a physician to rapidly obtain an answer regarding a potential pathology. It allows blood of other fluid testing outside the clinical environment. The first challenge for the sensing function is to be able to reach repeatability and reliability from one sensor to the other one. For this the control of the manufacturing process is critical. Two other challenges are to combine microfluidic functions, and to keep the manufacturing process simple to keep the costs low. We aim to use pad printing with appropriate inks and substrate, with a few post process steps to meet these challenges. In a previous work, we could demonstrate the soundness of this approach. Our goal is to mature this technology and to apply it to various types of biomarkers. As a possible example (and in collaboration with the department of life-science at BYU), a profile of biomarkers is expected to be quantified to detect cancer risks or cancer evolution.

Open-source manufacturing

With the development of 3D printers, electronic printed circuit services, Internet communication, and the sharing of open-source software through publicly reachable repositories, a new avenue has been opened for the manufacturing of open-source hardware solutions. This approach is complementary to the existing manufacturing methods. It is aimed at democratizing access to a series of products that are difficult to find on the market for various reasons. We aim to contribute to the development of this approach by designing unique device or systems, and by seeking to make 2D additive manufacturing (e.g. with pad-printing) as a simple manufacturing able to add valuable functionalities to such devices or systems. As examples, two applications are currently being developed:

1. We are developing a design and an approach to use 3D printers around the world in a safe way for the manufacturing of quality medical devices for the intramuscular self-injection of anaphylaxis emergency drug. As a result of achieving these objectives, there will be a substantially increased availability of such life-saving drugs for allergic people in low-income parts of the world, with improved hygiene, more medical efficiency.
2. We are developing an affordable mostly 3D printable experimental lab bench for the teaching of manufacturing of electronics and microsystems, as well as for instrumentation, with the ambition to share it through an open-source license. The short-term goal is to stimulate student learning by having them build and use these benches. The medium to long term goals are to stimulate education in Manufacturing Engineering, and to collaborate with other faculty members from BYU or other institutions to stimulate refinement of our bench, and to extend this approach to other experimental benches.

FUTURE PLANS

To keep my scholarship development at BYU, where the Gospel is part of the reality we can embrace as researchers, and where the mission is of most importance, I intend for 2024 to reach the following goals:

- Keeping a daily rhythm of doing at least 15 minutes writing (grant proposal or paper) and 15 minutes reading and making a half day per week exclusively reserved for uninterrupted scholarship work.
- Documenting my scholarship efforts in my scholarship logbook, to include the time spent on writing and reading, plus including the goal for the next day, and using this document for self-assessment of progress or for discussions with my mentor.
- Use, keep, and update when needed a research plan with the list of detailed ideas, activities, and priorities to reach the scholarship goals.
- Having the logistic of my research space to an acceptable to very good organization level to stimulate quality work for my graduate students, me, or other faculties from the department.
- Submitting at least two new articles for publication in quality peer-reviewed journals, starting publishing with my graduate students, and contributing to a high-quality conference.
- Submitting grant proposals for $500K or more, mainly from external funding sources.
- Volunteer to sit on an NSF review panel or equivalent this year.