BaNCE: A Model for *in vivo* Bacterial Non-Continuous Evolution and The Lifecycle of a Press Release

A Major Qualifying Project submitted to the faculty of Worcester Polytechnic Institute in partial fulfillment of the requirements for the Degree of Bachelor of Science.

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Table of Contents

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Forward

This joint Major Qualifying Project consisted of two parts: a biochemistry research project focused on creating a Bacterial Noncontinuous Evolution (BaNCE) system and a writing genre study that dove into the lifecycle of a press release. While working in the lab with my biochemistry partner, James Andon, to design, construct, and test this BaNCE system, I also worked with the WPI marketing department to understand the process of writing and publishing a press release at WPI to understand the genre's overall lifecycle and best practices. Although research of the biochemistry part of this MQP was cut short due to COVID-19, I brought the two projects together by applying my newfound knowledge of press releases to write a mock press release about my biochemistry research project.

Part 1: BaNCE: A Simplified Model for *in vivo* Bacterial Non-Continuous Evolution

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Abstract

Directed evolution is a powerful tool that has been honed to create new and improved proteins. One form of directed evolution, Phage-Assisted Continuous Evolution (PACE), developed by Dr. David Liu, elegantly links favorable mutations in an arbitrary gene of interest to a bacteriophage's ability to transfect a host. Inspired by PACE, this project explores the creation and viability of a Bacterial Non-Continuous Evolution model (BaNCE) that aims to conserve the mutagenic and selective properties of PACE while eliminating some of its complexities. BaNCE employs the use of three plasmids within E. coli. The first contains an error-prone polymerase that will make mutations to a second plasmid that encodes for a gene of interest. The final plasmid provides BaNCE's selective pressure via an auxotrophic selection model where prototrophy is restored by generation of favorable mutations in the gene of interest. Through preliminary research, we assembled the components of BaNCE and began to test this model's viability. In designing BaNCE, we hope to introduce a simplified version of PACE to increase directed evolution accessibility to academic labs.

Introduction

While it has not always been an in-lab technique, people have participated in directed evolution for centuries. About 11,000 years ago, Middle Eastern settlers began to farm their own crops to avoid relying on gathering. Their farming techniques present one of the first instances of directed evolution. For example, as they noticed that certain crops of wheat were more favorable than others, they began to save the seeds of these crops to sew better wheat, thus undertaking their own "artificial selection". Over time, farmers began to modify wheat traits to make more favorable crops, in ways such as selecting seeds that did not fall off the crop when they were ripe and ones that were more easily separable from the plant. Similar evolutionary processes have been used to transform other crops (The National Academies of Sciences, Engineering, and Medicine, 2008) and the idea of directed evolution has persisted since.

Laboratory directed evolution of proteins did not appear until 1993, when Chen and Arnold evolved the protein subtilisin E *in vitro*. To do this, they used error prone PCR to introduce random mutations into the subtilisin E gene. After mutation, proteins were expressed and screened for increased catalytic activity. Genes exhibiting favorable mutations were then subjected to further mutagenesis and screening. After three sequential rounds of mutagenesis and screening, they observed a 256 fold increase in the protein's catalytic efficiency. This experiment was the first to demonstrate the advantages of using a sequential mutagenesis-selection model to evolve proteins (Cobb *et al.,* 2013; Chen & Arnold, 1993).

One year after Chen and Arnold demonstrated the ability of error-prone mutagenesis to evolve proteins, Willem Stemmer demonstrated the evolutionary power of recombination. Stemmers' method involved creation of a library of analogous genes, which was then digested into smaller fragments. These fragments were then ligated together to recombine them into new genes. Favorable mutations were selected for by cloning the recombined genes into plasmids and expressing them to assess favorability. Stemmer used this method to evolve β-lactamase to confer a 320,000 fold increase in resistance to the antibiotic cefotaxime. The work done by Chen and Arnold and by Stemmer laid the framework for random mutation driven directed evolution. Despite the promise exhibited by this type of directed evolution, the large amount of time required to generate successive cycles of mutation and screening have impeded the usefulness of these methods. This issue would not be addressed for decades until researchers began devising ways of coupling mutagenesis and selection using *in vivo* systems (Cobb *et al.,* 2013; Stemmer, 1994).

In 2011, Dr. David Liu and colleagues conducted research on continuous evolution through their own method called PACE (Phage-Assisted Continuous Evolution), which involves "evolving genes transferred from host cell to host cell through a modified bacteriophage life cycle in a manner that is dependent on the activity of interest" (Carlson et. al., 2011). The PACE model involves the use of two DNA plasmids and a phage genome. The first plasmid, called the mutagenesis plasmid (MP), encodes for an error-prone polymerase that will generate random mutations in the system. The phage genome, called the selection phage (SP), contains the system's gene of interest (GOI). To create the SP, the pIII gene was excised from the phage genome and the GOI was inserted in its place (Carlson et. al., 2011)

Without pIII, phage infection rate drops by nine orders of magnitude. Consequently, pIII function must be restored for the phage to propagate and infect a greater number of host cells. Thus, to restore function, favorable mutations of the gene of interest must be linked to restoration of pIII expression, which is done by the system's second DNA plasmid. This plasmid, called the accessory plasmid (AP), encodes for a constitutively repressed pIII that provides the system's selective pressure. Expression of pIII is inhibited until favorable mutations in the GOI produce some change in the system that restores pIII expression to the AP. This has been done in various ways and largely depends on the type of GOI. In the first example of PACE, the GOI was a T7 polymerase which was evolved to recognize a novel promoter. This promoter was placed upstream of pIII in the AP, allowing pIII expression only to be restored if T7 could evolve to recognize the novel promoter (Carlson et. al., 2011).

In order to combine the MP, SP, and AP into one system, Liu and colleagues devised a "lagoon" (a fixed volume vessel) system. *E. coli* host cells are continuously pumped through the "lagoon" that contains replicating phages. The added *E. coli* cells contain the MP and AP. In order to regain infectiousness, pIII production must be restored to the phage faster than the lagoon can wash away the phages. To accomplish this, the phage will infect the *E. coli* host cells, which will then carry the MP, AP, and SP. Thus, the goal is for the error-prone polymerase from the MP to make random mutations to the GOI in the SP. Through selective pressure provided by the AP, a GOI with a gain of function mutation will be selected to continue to replicate, as the system can only survive with a mutation that increases the GOI's function enough so that it can restore pIII production in the AP (Carlson et. al., 2011).

The beauty of PACE is its ability to evolve any gene that can be linked to pIII production in *E. coli* (Carlson et. al., 2011) and it has shown promising results across a large number of publications. In an even more recent paper (Roth et. al., 2019), Dr. David Liu and co-workers demonstrated PACE's ability to evolve the *Bacillus methanolicus* methanol dehydrogenase protein, Mdh2, to improve its catalytic rate. Liu *et al.* demonstrated that their modified Mdh2 was faster than any other modified Mdh2 previously described. Liu's goal in improving Mdh2 catalytic activity had implications for developing methylotrophic *E. coli* to convert methane into metabolites for metabolism integration. Thus, his research could have implications for greenhouse gas reduction.

Due to greenhouse gases, such as methane, the Earth's temperature is rising as the greenhouse effect is worsening (Climate Action Reserve, 2019). Average surface temperature of the Earth has risen 0.9 degrees Celsius since the late 19th century (NASA, 2019). It is predicted that, without interference, global temperatures could increase by 10 degrees Fahrenheit by 2100, causing irreversible changes to Earth's climate (Climate Action Reserve, 2019). Methane has a particularly detrimental effect on the atmosphere as its greenhouse effects are 34 times that of carbon dioxide. Fossil fuels and livestock are two major sources of atmospheric methane (UNFCCC, 2019), which, in 2017, accounted for 10% of the United States' greenhouse gas emissions (EPA, 2019). Currently, there is no easy way to rid the atmosphere of methane other than prevention or combustion. However, as shown by Dr. Liu, directed evolution is a possible solution to reduce methane emissions.

While PACE is a powerful method, the complexity of the system may deter other labs with fewer resources from investigating PACE on their own. Specifically, we found that the use of phages and a complex pump system would be too time consuming to establish this model in our own lab. To address this, we designed our own method of continuous directed evolution with simplicity and ease of use in mind, called the BaNCE (Bacterial Non-Continuous Evolution) method. In order to assess the viability of BaNCE, results from the Mdh2 PACE experiments were attempted to be replicated. To assess the viability of this proposed system relative to PACE, we aimed to compare the catalytic efficiency of a BaNCE evolved Mdh2 to PACE's Mdh2.

The main aspect of PACE we wanted to eliminate was the use of viruses. PACE uses the M13 filamentous bacteriophage to link favorable mutations to the propagation of progeny. The crux of PACE hinges on connecting these favorable mutations of the gene of interest to expression of *pIII*. In Liu's Mdh2 PACE experiments, this was done by using a formaldehyde sensitive transcription factor (FrmR) to repress *pIII* expression. Since Mdh2 converts methanol to formaldehyde, increased enzymatic activity correlates to an increase in formaldehyde concentration. In Liu's model, Mdh2 improvement caused an increase in formaldehyde concentration, causing decreased FrmR repression of *pIII* and thus phage reproduction (Carlson *et al.,* 2011; Rother *et al.,* 2019).

Overall, the hypothesized BaNCE system is composed of three plasmids and is performed within *E. coli*. The first plasmid, called pEP, encodes for the Error Prone (EP) DNA polymerase involved in making mutations. It will mutate a second plasmid, called pMdh2, which encodes for methanol dehydrogenase (Mdh2), BaNCE's gene of interest. The goal is for the EP DNA polymerase to introduce a gain of function mutation into Mdh2 that will improve the rate at which Mdh2 can convert methanol into formaldehyde. Sensing an increase in formaldehyde formation will be done through BaNCE's third plasmid, pMetA. This plasmid contains *MetA*, which is a gene essential for methionine biosynthesis. The system will be performed in *E. coli* cells with *MetA* knocked out, inhibiting the methionine biosynthetic pathway. Regaining of *MetA* is essential for the *E. coli* cells to survive in a methionine deficient environment. In pMetA, *MetA* is regulated under the same formaldehyde (Frm) promoter/operator as used in PACE, which is bound by the formaldehyde repressor (FrmR). Only a large enough increase in formaldehyde will result in binding of formaldehyde to FrmR, thus releasing it from the operator and allowing transcription of *MetA* and subsequent *E. coli* growth restoration. As this system eliminates the use of phages, the hope is that it will make a form of directed evolution more accessible to other research labs, thus combating the complexity of a phage-centric system.

Materials and Methods

MetA- Competent Cell Preparation

100 mL of LB broth with a kanamycin (Kan) concentration of 25 µg/mL was inoculated with 5 µL of liquid MetA- cell culture. Cells, along with 500 mL of LB broth, were placed in a 37°C incubator overnight. The following day, 400µL of 50µg/mL Kan was added to the LB broth. Target OD600 of the cell culture is between 0.400 and 0.600, so the OD600 of the current culture was measured and a portion of the culture was added to the 500mL LB+Kan broth to achieve an OD600 of 0.100. Cells were then incubated and measured every 20 minutes until the OD600 measured close to the target. Cells were then incubated on ice for 10 minutes and 2, 50 mL aliquots were placed into tubes and spun down at 3500x g at 4°C for 15 minutes. The supernatant was decanted and cells were resuspended with 2.5 mL of 50 mM MgCl2 and vortexed. The total volume of the tube was then raised to 25 mL with 50 mM MgCl2. Cells were centrifuged for 15 more minutes at 3500x g at 4°C. The supernatant was again decanted and cells were resuspended again with 2.5 mL of 50 mM MgCl2 and vortexed to mix. The total volume was then raised to 12.5 mL with MgCl2. Cells were incubated on ice for 25 minutes and then pelleted at 3500x g for 10 minutes at 4°C. 80% of the supernatant was decanted and cells were resuspended in the remaining liquid. The culture was then transferred to clean tubes and pelleted at 3500x g for 15 minutes at 4°C. The supernatant was aspirated and the cells were resuspended in 2.5 mL of 50 mM CaCl2. Glycerol was added to make a 15% stock solution and tubes were snap-freezed in liquid nitrogen and stored at -80°C.

Dropout Media

Since *E. coli* cells lacking *MetA* were used, a dropout media lacking methionine was needed. To make the dropout media, the following components were mixed: 200 uL 5x M9 Salts (to make M9 salts, in 500 mL of DI water, combine and mix 32g $Na_2HPO_4•(H_2O)_7$, 7.5g KH_2PO_4, 2.5g NH_4Cl, and 1.25g NaCl), 200 uL 1M $MgSO_4$, and 10 uL 1M $CaCl_2$, 0.192g dropout mix (amino acids minus methionine). DI water was added to bring the total volume up to 98 mL. 2 mL of 20% glucose was then added to the solution to bring the final volume to 100 mL. When needed, for control experiments, 8.2 mL of 78.5 mM methionine was added to the media, prior to the addition of DI water.

Transformations

Approximately 100 µL of appropriate cells for transformations were thawed on ice. 15 ng of target DNA was added to the cells, gently mixed, and incubated for 30 minutes on ice. Cells were then heat shocked at 42°C for 20 seconds and placed back on ice for 5 minutes. 450 µL of LB broth was added to the cells, which were then incubated for 1 hour at 220 rpm and 37°C. Following incubation, between 75 and 150 µL of cells were spread onto an appropriate plate and incubated overnight at 37°C.

Table of Transformations

Plasmid	Cell Line(s)	Antibiotic(s)
pMdh2	JM109, BL21	Streptomycin
pEP	JM109, BL21 MetA-	Chloramphenicol
pBAD MetA WT	MetA-	Kanamycin
pStart-T2	MetA-	Tetracycline
pMetA	MetA-	Tetracycline
None	MetA-	Kanamycin (natural resistance)

DNA Mini Preps

To extract and purify plasmids throughout this project, Promega miniprep kits were used. 3mL of c3mL of cells with target DNA were grown overnight. The next day, 600 µL of culture were added to a 1.5 mL tube. To the tube, 100 µL of cell lysis buffer was added and inverted six times to mix. After mixing, 350 µL of cold neutralization buffer was added and mixed until cloudy and yellow. The mixture was centrifuged at 20,000 rcf for 3 minutes. Following centrifugation, the supernatant was transferred to a minicolumn with a collection tube and was again centrifuged at 20,000 rcf for 20 seconds. Flowthrough was discarded and 200 µL of Endotoxin removal wash was added to the tube, which was then centrifuged again at 20,000 rcf for 20 seconds. 400 µL of Column wash was then added and centrifuged at 20,000 rcf for a 30 second interval. The column was transferred to a clean tube and 30 µL of Elution buffer was added and allowed to sit at room temperature for 1 minute. Following incubation, the tube was centrifuged for 20 seconds at 20,000 rcf to elute the DNA.

Mutagenesis Test

An experiment was performed to test for EP DNA Pol I's mutagenesis. 3mL of LB broth, 2.2 µL of Cm (Chloramphenicol, 34 g/L), and 30 µL of Strep (Streptomycin, 10 g/L) were added to a culture tube. Colonies pre-picked from an overnight culture of double transformant cells with pMdh2 and pEP DNA pol I were inoculated into the tubes. Tubes were grown overnight at 220 rpm and 37°C. In addition, single transformants of pMdh2 and pEP were inoculated into LB+Strep and LB+Amp culture tubes respectively as a control and also grown overnight. Following overnight growth, cells were passed and again grown overnight. The next day, cells were passed, induced with IPTG and arabinose for induction, and scaled up into 40 mL of liquid culture to prepare for protein extraction and DNA purification.

Agarose Gel Electrophoresis

50 mL of a 0.9% agarose solution in 1x TAE was prepared and microwaved for 1 minute. Once the solution was cool enough to touch, 1µL of Ethidium Bromide was added and swirled to mix. The agarose solution was poured into a gel mold and allowed to harden. 10 µL of DNA ladder was added to the first lane with DNA samples added to subsequent ones. It was then run at 90V for 1 hour and products were viewed on a UV transilluminator.

Restriction Cloning

Restriction cloning was used to insert *MetA* into the pStart-T2 plasmid. First, a ~200 ng load of DNA (6.3 uL of 30.1 ng/uL pStart-T2 or 38.3 ng/uL *MetA* insert) was digested by incubating it with 2 uL 10x CutSmart buffer, 2 uL ApaI (NEB), 2 uL XhoI (Promega), and 7.7 uL ddH_2O at 37°C for 1 hour. Each reaction mixture was then heat inactivated by incubating at 65°C for 20 minutes. Next, the restricted DNA was recovered using a Promega Wizard PCR Cleanup Kit using the supplied protocol. To ligate *MetA* into pStart-T2, 6.6 uL of restricted pStart-T2 (15.7 ng/uL), 1.3 uL of restricted insert (12.8 ng/uL), 1 uL Ligase 10x buffer (Promega), and 1 uL T4 Ligase (Promega) were incubated overnight at 4°C. To test ligation efficiency, 2 uL of ligation mixture and 2 uL of pStart-T2 (30 ng/uL) were each transformed into competent MetA- *E. coli* and growth levels compared.

Protein Quantification Assay

A protein quantification assay was used to normalize protein concentration for SDS-PAGE. First, a standard curve was prepared by performing a 5x dilution of 10 mg/mL bovine serum albumin (BSA), and then five 2x serial dilutions. Likewise, each protein extract sample was diluted using three 2x serial dilutions. Then, 50 uL of each sample was loaded into a 96-well plate and mixed with 250 uL Pierce™ 660nm Protein Assay Reagent (Thermo Scientific). A blank was prepared by mixing 50 uL water with 250 uL reagent. The samples were incubated at room temperature for 20 minutes and optical density was observed at 595 nm wavelength.

Protein SDS-PAGE

12% Polyacrylamide gels were cast using the following protocol. The resolving gel was cast by mixing 4 mL of 30% acrylamide/1% bis-acrylamide, 2.5 mL resolving buffer (1.5 M Tris-HCl, pH 8.8), 3.4 mL ddH_2O, 0.1 mL 10% SDS, 550 uL 20% ammonium persulfate, and 7 uL TEMED. For the stacking gel, 0.65 mL 30% acrylamide/1% bis-acrylamide were mixed with 1.25 mL stacking buffer (0.5 M Tris-HCl, pH 6.8), 3 mL ddH_2O, 50 uL 10% SDS, 25 uL 20% ammonium persulfate, and 5 uL TEMED. In addition to in-house gels, 16% BioRad Mini-PROTEAN precast gels were also used. Samples were diluted five-fold in the loading buffer (0.1% bromophenol blue, 0.1 M EDTA pH 8.0, 30% glycerol) to a final volume of 40 uL and heated at 95 °C for 5 minutes. Handcast gels were run at 25 mA until the dye ran off the gel and precast gels were run 30 mA. Following, gels were stained with a blue staining solution (0.1% Coomassie Brilliant Blue R-250, 50% methanol, 10% acetic acid). Gels were gently mixed in the solution for approximately 30 minutes. Following staining, gels were destained overnight in destaining solution (50% methanol, 10% acetic acid). Gels were then imaged on a BioRad gel imager.

Results

Plasmid Design

From research done in Dr. David Liu's lab, phage-assisted continuous evolution (PACE) has emerged as a powerful tool to evolve proteins. This system hinges upon the rapid replication rate of the M13 bacteriophage and its inability to replicate without the *pIII* gene. In PACE, *pIII* is replaced with a gene of interest that can restore *pIII* function if it evolves favorably. In one application of PACE, methanol dehydrogenase II (Mdh2) was evolved for better catalytic efficiency by linking formaldehyde production to regaining of *pIII* expression via a formaldehyde sensitive transcription factor. To ensure a constant supply of host bacteria for the phage to replicate in, PACE employs a complex pump system called a lagoon. Due to the complex nature due to the use of phages and a lagoon pump system, we wanted to simplify this model through designing a bacterial non-continuous evolution method which we called BaNCE.

Instead of the phage-bacteria combination used by PACE, we decided to only use *E. coli*. Despite the two-fold reduction in reproduction time, its ease of use and extensive library of research makes *E. coli* a prime candidate for the BaNCE model. To create a directed evolution scheme for *E. coli*, a way to link favorable mutations in Mdh2 to cell survival was devised. To do this, an amino acid dropout model was designed. In order to survive, *E. coli* requires access to all 20 amino acids. In this model, a non-essential amino acid was pursued so, through the BaNCE model, its biosynthesis could be impeded and subsequently restored within the cell. By knocking out a protein in the biosynthetic pathway for an amino acid, *E. coli* cells will only have access to 19 of the 20 required amino acids, thus causing cell death. To regain the function of the amino acid dropout, favorable mutations in Mdh2 will need to be linked to production of a specific amino acid to ensure cell survival.

To identify the best knockout candidate, a literature review was conducted to research past experiments that identified auxotrophic *E. coli* available from the Coli Genetic Stock Center (CGSC). Eleven auxotrophic *E. coli* were examined to identify single gene knockouts that produced bacteria incapable of growing on media lacking a specific amino acid. Nine of the eleven mutants tested were incapable of survival without their amino acid of interest supplemented in growth media. Of those nine, MetA (from the methionine biosynthetic pathway) and PheA (from the phenylalanine biosynthetic pathway) had the highest range of growth linearity with respect to amino-acid-of-interest concentration. Of those two candidates, the *MetA* knockout was chosen for its smaller gene size compared to PheA (Bertels *et al.*, 2012).

The next piece of the design process was to find a method of *in vivo* mutagenesis. PACE uses a specialized, low-fidelity DNA polymerase to make mutations in phage DNA. This polymerase is nonspecific and will reproduce any and all DNA it can access. This is not an issue in PACE since the phages replicate faster than the bacteria, meaning that any mutations to bacterial genomic DNA will not matter because the phage will reproduce before the bacteria, and any mutated bacteria will be washed out and replaced by the lagoon. However, since the BaNCE method requires that the bacteria can reproduce continuously, mutations to genomic DNA are not tolerable. To fit this restriction, a DNA polymerase that is origin specific was required. A highly error prone DNA polymerase I (EP-DNAP I) that exhibits preference for ColE1 origins of

replication was chosen as the best candidate. This polymerase produces mutations at a rate of 8.1 x 10^{-4} mutations per base pair, an 80,000 fold increase relative to wild type DNA polymerase I (Camps *et al.*, 2003).

Figure 1 shows the hypothesized BaNCE system. The first plasmid involved is called pEP (the error-prone polymerase plasmid). This plasmid encodes the Error Prone DNA Polymerase I protein, which will introduce random mutations into the DNA of the second plasmid, called pMdh2 , which encodes methanol dehydrogenase. Once EP DNA Pol I is transcribed from pEP, shown by the purple protein, it will recognize the ColE1 origin of the pMdh2 plasmid and bind to it. The EP DNA Pol I will then initiate pMdh2 replication and introduce random mutations into the growing pMdh2, shown by the wavy red circle. The introduced mutations within *Mdh2* are designated by a red star. Overall, the goal of introducing mutations is to create a gain of function mutation that will improve the rate at which Mdh2 can convert methanol to formaldehyde. Selection of a favorable mutation is based upon sensing an increase in formaldehyde production. This is done via this system's third and final plasmid, pMetA, which contains *MetA* and has been knocked out of the MetA- *E. coli* (Strain JW3973-1 from the Coli Genetic Stock Center) used in this system. Regaining of *MetA* is essential for these auxotrophic cells to survive. *MetA* is regulated under the formaldehyde (Frm) promoter/operator which is bound by the formaldehyde sensitive transcription factor FrmR. A favorable mutation in Mdh2 resulting in a significant increase in formaldehyde concentration causes FrmR to be irreversibly bound to formaldehyde, thus releasing it from the operator and allowing transcription. Once *MetA* is transcribed, methionine biosynthesis is restored to the bacterium.

When fully assembled, the BaNCE model consists of one *E. coli* strain with three transformed plasmids described in Figure 2. The pEP plasmid, responsible for generating mutations in the gene of interest, contains EP DNA Pol I under the IPTG inducible lac promoter. The lac promoter was chosen for its low expression as high levels of mutagenic polymerase could extensively mutate the *E. coli* genome and could risk cell survival. The pMdh2 plasmid, which contains the gene of interest, encodes Mdh2 under a ColE1 origin of replication and is the only plasmid in the system regulated by ColE1. Lastly, pMetA, responsible for linking evolutionary pressure to favorable mutagenesis, contains *MetA* with a FrmR promoter.

In principle, EP-DNA Pol I will mutate *Mdh2*, which will produce varying levels of formaldehyde depending on whether the mutation is favorable or not. If the mutations result in an increase in formaldehyde concentration, *MetA* will be transcribed via release of the FrmR repressor. Increased *MetA* expression will result in increased cell survival, creating a cycle where only favorable mutations are propagated.

Replicon Selection

Plasmid incompatibility poses a potential problem to a three plasmid system. Competition for the same replication machinery occurs between plasmids within the same incompatibility group, meaning that two plasmids from the same group cannot coexist. Furthermore, small RNA produced by a plasmid to regulate copy number can interfere and prevent the coexpression of two plasmids with the same origin in a single bacterium. To avoid this, we identified three unique replicons from different incompatibility groups: ColE1, a high copy number origin to be

used for pMdh2, pSC101, a low copy number origin to be used for pEP, and p15A, a medium copy number origin to be used for pMetA (Rosano & Ceccarelli, 2014).

The agarose gel shown in Figure 3 pictures replicon compatibility of pEP, which contains a pSC101 origin, and pMdh2, which contains a ColE1 origin. Plasmids that are too closely related will be incompatible, so this gel was run to ensure that the two plasmids were able to coexist in the same cell line without replicon competition. Both plasmids were co-transformed into MetA- *E. coli* cells. The top band shown in lane 2 appears at around 6kb, while the bottom band is seen at about 5kb. These are the expected lengths of both pEP (6.2 kb) and pMdh2 (4.7 kb). Thus, as both plasmids were apparent on the gel, it proves that both the pEP plasmid and pMdh2 plasmid can be co-expressed in the MetA- cell line.

Methionine Auxotrophy *E. coli* Selection

To ensure that the auxotrophic *E. coli* could not grow in the absence of methionine, MetA- cells were grown on custom dropout media lacking methionine or dropout media with methionine supplemented back in. No MetA- cells grew on the dropout media, however, growth was robust on the dropout media with methionine. Interestingly, MetA- cells that grew on dropout media were cloudy and less defined than MetA- cells grown on LB agar plates.

pMetA Construction

A pBAD MetA WT plasmid was received from Scripps College, care of the Dr. Peter Schultz lab, to excise the MetA gene for construction of the pMetA plasmid. The MetA gene needed to be cloned out of the pBAD vector and into a p15A replicon plasmid. pStart-T2 was chosen because it contains the p15A origin and an antibiotic selection (tetracycline) which was compatible with pMdh2 and pEP (streptomycin and chloramphenicol, respectively). The insert needed to include restriction sites for insertions, the Frm promoter and operator, and the MetA gene. In order to successfully clone this from the pBAD vector, an overhang PCR was conducted. A set of forward and reverse primers, shown in Figure 3, were designed for the PCR reaction and for successful cloning. Primers included the Frm promoter region, restriction sites, and overhangs for enzymes to sit atop.

Following PCR, an agarose gel, shown in Figure 3, was run to ensure primer amplification. In lane 2, a band was observed near 100 bp, which is the expected size of the MetA insert, showing that PCR and primer amplification were successful.

A DpnI restriction digest was run on the remaining PCR product to ensure that any remaining genomic DNA was removed. Following the digest, the MetA insert underwent restriction cloning into the pStart-T2 plasmid to create pMetA and to excise the ccdB gene, which encodes for the CcdB protein that causes cell death, from the pStart-T2 plasmid. After ligation, MetA- cells were transformed with the ligation reaction mixture and grown overnight in parallel with MetA- cells transformed with pStart-T2 as a negative control. Three colonies grew on the pMetA plate, while no growth was seen on the pStart-T2 plate. Since cells grew, this tentatively shows that the restriction/ligation was a success.

Mutagenesis Experiments

To test the efficiency of EP DNA Pol I, mutagenesis experiments were run to check if it could not only mutate pMdh2, but that it was possible for *E. coli* to express both plasmids. Chemically competent MetA- cells were transformed with varying plasmids plated on LB+Agar plates with associated antibiotics. Sample 1 contained pEP with chloramphenicol resistance, sample 2 with pMdh2 and streptomycin resistance, and Sample 3 with both pEP and pMdh2 with chloramphenicol and streptomycin.

Following transformations, transformed pEP cultures were plated on LB+Cm plates, pMdh2 on LB+Strep plates, and pEP+pMdh2 on LB+Cm+Strep plates to prepare for mutagenesis experimentation. Colonies were grown overnight and growth, with consistent phenotype, was seen on all three plates. On day zero, a single colony from each plate was picked and grown overnight in 3mL of LB broth with associated antibiotics. The following day, day one, cells were passed and grown again overnight to give pEP the chance to further mutate pMdh2. On the second day of growth, cells were passed, induced with IPTG and arabinose for induction, and scaled up into 40 mL of liquid culture and again grown overnight to prepare for a protein extraction and DNA purification.

Following mutagenesis and prior to protein extraction, an aliquot of each sample was taken for DNA purification. Following purification, the selected colonies were sent to be sequenced to determine if the pEP and pMdh2 plasmids were present in *E. coli* in samples 1 and 2 and if pEP was able to successfully mutate pMdh2 in sample 3. The plasmids were sequenced using primers flanking the *Mdh2* gene, which is 1,158 bp. All sequencing results showed an exact match between the sequenced plasmid and the *Mdh2* gene, meaning that we did not observe any mutations in the *Mdh2* coding region resulting from cotransformation with pEP.

A PAGE gel was then run using the 3 samples to test whether proteins were expressed and if co-expression was possible. Figure 7 shows the results of this PAGE gel. Lane 1 contains a protein ladder with weights labeled. Lane 2 contains Sample 2 with EP DNA Pol I, where a band would be expected at about 109 kDa. A dark band can be seen at around 15 kDa. Lane 3 contains Sample 3 with Mdh2, with a band seen at the expected 40.7 kDa. Lane 4 contains both EP DNA Pol I and Mdh2, with a band seen at the appropriate weight for Mdh2, but no band seen for EP DNA Pol I.

This gel shows that it is possible for Mdh2 to be expressed in MetA- *E. coli* cells, but since EP DNA Pol I is not seen at the expected weight, a new set of protein extracts, along with a control, were prepared. In addition, prior to a PAGE gel, a Pierce Assay was run to measure protein concentration in the case that the extracts were either too concentrated or not concentrated enough for EP DNA Pol I to appear clearly on a PAGE gel.

Figure 8 shows the results of this Pierce Assay. For this assay, the standard was first diluted fivefold, and followed by five 2x serial dilutions. The samples were tested at their original undiluted concentration as well as after they underwent three 2x serial dilutions. Sample 1, which is a negative control of protein extract from MetA- cells with no transformed plasmids, had a concentration of 1.8 mg/mL. Sample 2, cells transformed with pEP, had a concentration of 3.0

mg/mL. Sample 3, cells with pMdh2, had a concentration of 8.9 mg/mL. Sample 4, cells with both pEP and pMdh2, had a concentration of 14.0 mg/mL. Table 3 shows OD values corrected for the blank measurement. From this data, to create a uniform protein concentration, Sample 1 was left undiluted, Sample 2 was diluted to a 2-fold, Sample 3 was diluted 4.5-fold, and Sample 4 was diluted seven-fold.

The resulting PAGE gel from the protein extract dilutions can be found in Figure 9. Lane 1 of the gel contains a protein ladder. Lane 2 contains Sample 1, the MetA- cell extract negative control. Lane 3 contains Sample 2, lane 4 contains Sample 3, and lane 5 contains Sample 4. In both lanes 3 and 4, the pMdh2 plasmid can be seen with a band at the expected 40.7 kDa. While no band can be seen for pEP at the expected 109 kDa, a band can be in boths lanes 3 and 5 at around 20 kDa. In lanes 2 and 3 of Figure 7, this band can also be seen at around 20 kDa. Since this band does not appear in lane 2 of Figure 9, the control extract, it is likely that this band correlates to the presence of pEP. Further experimental evidence needs to be collected to make this conclusion.

Discussion

Directed evolution has proven itself as a powerful tool for creating new and improved proteins. In this report, we outline a novel system for non-continuous directed evolution which aims to conserve the elegance of the PACE model while simplifying some of its more complex features. In addition to the design of a Bacterial Non-Continuous Evolution (BaNCE) system, we report preliminary findings which test the feasibility of this model. We demonstrated that the JW3973-1 strain of *E. coli* (referred to as MetA- in this paper) is capable of being transformed with two plasmids using a ColE1 and pSC101 replicon. Additionally, we have shown that these cells are incapable of growing on our custom dropout media which lacks methionine, but that growth can be restored by supplementing methionine back into the media. We also present data that suggests the successful construction of BaNCE's third and final plasmid, pMetA, which includes a p15A replicon and the *MetA* gene regulated under the Frm promoter/operator. Lastly, we present data which assesses the ability of MetA- cells to coexpress multiple proteins from separate plasmids and the ability of EP DNA Pol I to generate mutations *in vivo* under low expression conditions. These data inform us on the potential of the new BaNCE model, possible modifications to the system, and future experiments to further appraise the feasibility of BaNCE.

Unfortunately, due to the COVID-19 pandemic, we were unable to complete the research we had hoped to finish since WPI's campus was put on lockdown and students were asked to return home and take classes remotely for the remainder of the academic year. For this reason, the results of this project ended more abruptly than expected, leaving unfinished work due to the sudden closure of the lab. As a result, the discussion section will place a heavy focus on speculations and possible conclusions of the completed research, next steps that had been planned to be completed, as well as possible future directions for this project.

Through methionine auxotrophy selection experiments, shown in Figure 4, we were able to prove that MetA- cells cannot grow without a methionine supplement in pre-made growth media. This shows that, if the pMetA plasmid were to express *MetA*, thus restoring methionine biosynthesis to the MetA- cells, they should grow on dropout media. Regardless, further experimentation of MetA- cells should be run as a phenotype change in the cells can be seen in Figure 4 when they are grown on dropout media with a methionine supplement (4B) versus LB broth (4C) to ensure that this change does not affect BaNCE experimental results. Once all three BaNCE plasmids are transformed into the cell line, a growth test on dropout media will be needed to show that the system works as predicted.

Prior to halting of experimentation, the final plasmid in the BaNCE system, pMetA, was constructed. The data shown in Figure 6, whose gel proves that primer design and cloning were successful. In addition, growth testing following ligation showed that MetA- cells transformed with pMetA were able to grow, while those in the unrestricted pStart-T2 plasmid did not, proving that the ccdB gene was excised. While construction of pMetA should be confirmed through sequencing, this promising data suggests that all three BaNCE plasmids have been constructed, and the system can be tested to completion.

Since all three plasmids are available for BaNCE system experimentation, a triple transformation into MetA- cells needs to be performed to confirm replicon compatibility. Figure 3 shows an agarose gel that proves that not only can both pEP and pMdh2 be transformed into MetA- cells, but the two distinct bands in lane two prove replicon compatibility. Through a triple transformation of the three BaNCE plasmids, three distinct bands on a gel would prove that all three replicons are compatible. Replicon compatibility is needed for overall success of the BaNCE model as, if the plasmids were competing for the same replicon, transformation and plasmid perpetuity would not be possible.

Despite attempting several mutagenesis experiments, we were unable to observe the generation of any mutations in ColE1 plasmids. In these experiments, MetA- *E. coli* were cotransformed with pEP and a ColE1 target plasmid, for which we used pMdh2. Although sequencing showed no mutations in the *Mdh2* coding region, this does not disprove the introduction of mutations elsewhere in the plasmid. Furthermore, because the mutations generated by EP DNA Pol I are random, the average sequence of a collection of plasmids may appear unchanged, even though the plasmids may individually have each accumulated a small number of mutations. For sequencing of a population of plasmids to be a useful tool to determine the mutagenicity of EP DNA Pol I, it may be necessary to concentrate plasmids with the same mutations so that these may be observed using sequencing. The use of a ColE1 plasmid encoding GFP could help identify when mutations are generated by a change in the bacteria's phenotype. If colonies transformed with both pEP and a GFP/ColE1 plasmid change from glowing to dark, this could be indicative of a mutation in the coding region of GFP. However, it is important to note that a change in phenotype could also result from mutations in the promoter/operator of GFP, which could hinder transcription, or from mutations in the replicon, which would hinder plasmid replication. The latter would also require the cells to gain resistance to associated antibiotic selection. Regardless of the method, proving EP DNA Pol I's ability to generate targeted mutations *in vivo* is essential to establishing BaNCE's potential as a system for directed evolution.

Likewise, the ability for MetA- cells to express the key proteins encoded in each of BaNCE's plasmids is critical to the model's success. Figure 7 shows the results of a SDS-PAGE gel using protein extracts of MetA- cells transformed with either pEP, pMdh2, or both plasmids. In lane 3, labeled Mdh2, there is a large band located around 40 kDa. Given the size of the band and its location, this was determined to be Mdh2, which has a molecular weight of 40.7 kDa. A fainter band can be seen at the same location in lane 4, labeled EP DNA Pol I and Mdh2, suggesting that Mdh2 is successfully expressed in both pMdh2 and pEP/pMdh2 transformed cells. However, because the bands in lanes 3 and 4 differ greatly in intensity, it was concluded that protein concentrations between samples differed greatly. In contrast to Mdh2, EP DNA Pol I, which has a weight of 109 kDa, is not apparent in lane 2, labeled EP DNA Pol I, nor in lane 4. There are heavy bands around 15 kDa and 5 kDa that do not appear in the Mdh2 only lane, however, the nonuniform concentrations make it difficult to determine whether these are a product of pEP's presence or a result of different concentrations of host cell proteins. Although EP DNA Pol I's absence on this gel is alarming, it was expected to have lower expression levels than Mdh2 given the differences in copy number and induction between pEP and pMdh2. pEP employs the low

copy number pSC101 origin and regulates EP DNA Pol I expression under the lac system, which has a history of temperamental induction. pMdh2 uses the high copy number ColE1 replicon and arabinose induction. These distinctions help explain the differences between Mdh2 and EP DNA Pol I concentrations on the gel, but they do not explain the complete absence of EP DNA Pol I. To further investigate this, the experiment was reattempted with the addition of a Pierce 660 assay to normalize protein concentrations between samples as well as a negative control to help visualize differences in protein concentrations.

Figure 9 shows the results after protein concentration normalization. Once again, Mdh2 has a clear presence in both the lanes containing pMdh2, however, now band intensities are comparable between the two samples. Nevertheless, there is once again an absence of any significant bands around 110 kDa where EP DNA Pol I is expected to be found. Interestingly, there is a significant band present at 20 kDa, which is noticeably darker in both samples containing pEP (lanes 3 and 5), than it is in the control. This band seems to correlate to the presence of pEP, but we cannot conclude that it signifies the expression of EP DNA Pol I. Although these results do not confirm expression of EP DNA Pol I, they do not disprove it either. The previously described conditions causing low EP DNA Pol I expression may make this experiment non-ideal for identifying expression of EP DNA Pol I since it may not be present in concentrations high enough to distinguish itself from other proteins in the extract. Introducing a protein tag to EP DNA Pol I and subsequent purification may be required to determine conclusively whether or not the current plasmid system allows for expression of the polymerase.

Through the use of the BaNCE system, we hoped to create an easier, more user-friendly model for directed evolution that could be performed in academic labs without the complexity of phages. Seeing as the PACE method poses implications for methane pathways, we hope that the simplified BaNCE method could have potential to create pathways that could convert methane into energy sources for bacteria.

Figures and Tables

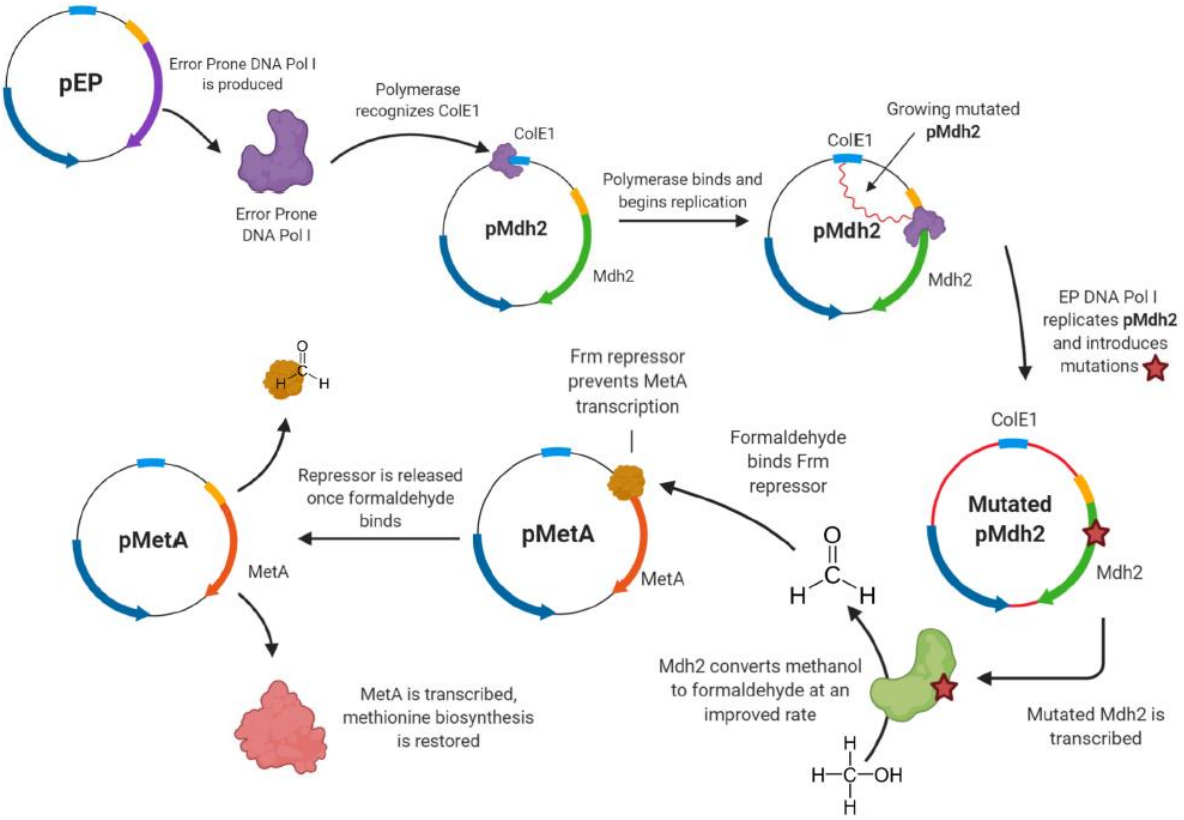

Figure 1. BaNCE experimental design. Beginning with the pEP plasmid, the error prone (EP) DNA Polymerase I will be transcribed. This polymerase will then recognize the ColE1 ORI of the pMdh2 plasmid and bind to it. The EP DNA Pol I will then replicate the pMdh2 plasmid and introduce random mutations, thus creating a mutated pMdh2, delineated by the wavy red circle. The introduced mutations within the Mdh2 gene are shown by a red star. The goal is to create a gain of function mutation that will allow Mdh2 to convert methanol to formaldehyde at an improved rate. As a result, the mutated gain of function Mdh2 will be selected for continued replication and transcribed. Thus, the formaldehyde from Mdh2 converted methanol will bind to the formaldehyde (Frm) repressor on pMetA, shown by the orange molecule. Once formaldehyde binds to the Frm repressor, it will be released from pMetA, thus allowing for the transcription of the MetA gene. As a result, methionine biosynthesis will be restored and the MetA- *E. coli* cells will be able to grow and propagate.

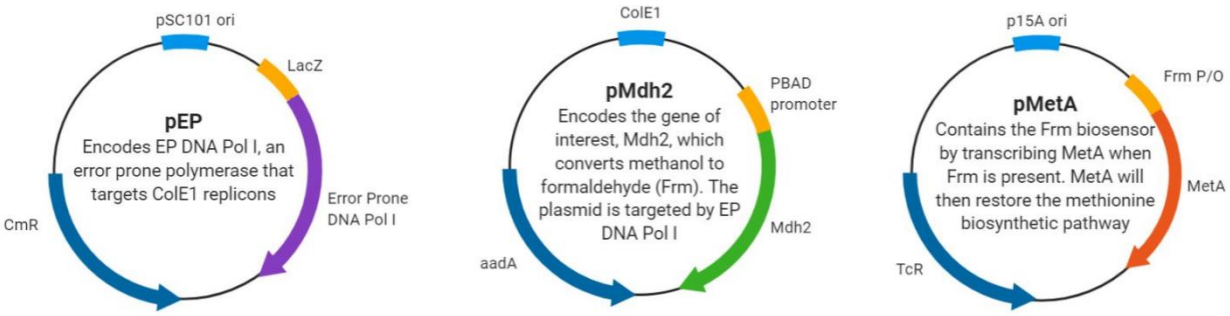

Figure 2. Simplified Plasmid Maps of plasmids used. The pEP plasmid that will make random mutations to the pMdh2 plasmid through the use of Error Prone Polymerase I. The pMdh2 plasmid contains the gene of interest, Mdh2 (methanol dehydrogenase), that will convert methanol to formaldehyde. pMdh2 mutations from the pEP plasmid will produce varying levels of formaldehyde depending on a favorable mutation. The pMetA (Methionine) plasmid links evolutionary pressure to the favorable mutagenesis of the pMdh2 plasmid.

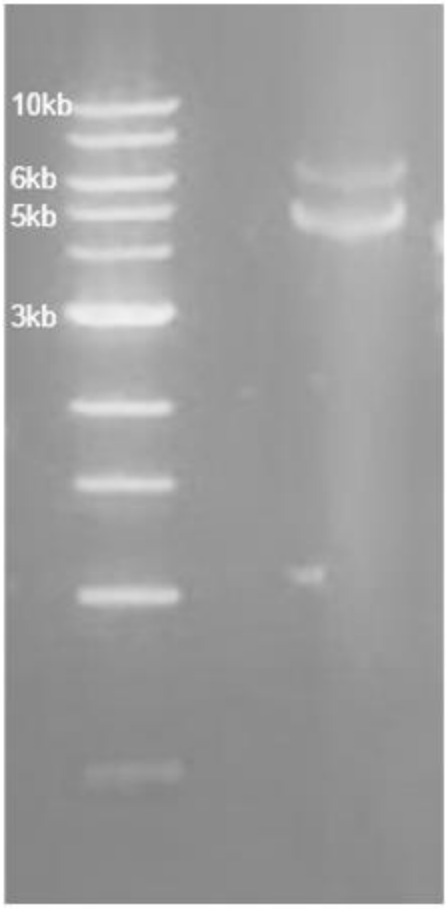

Figure 3. Agarose gel of replicon compatibility. Lane 1 pictures a 2-log DNA ladder with associated lengths labeled. Lane 2 shows a co-transformation of pEP and pMdh2 done in MetA-*E. coli* cells. Bands can be seen at 6kb, which is near the expected length of pEP (expected 6.2 kb), and just shy of 5kb, which is near the expected length of pMdh2 (expected 4.7 kb). These two distinct bands prove replicon compatibility of these two plasmids.

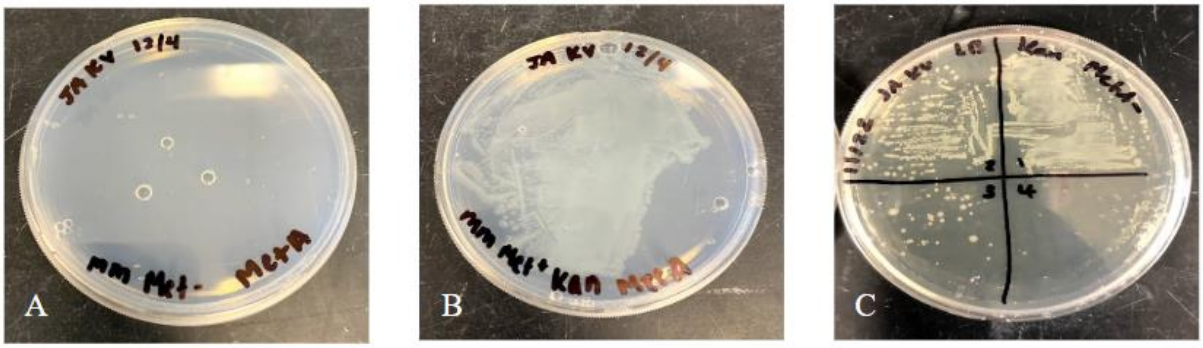

Figure 4. MetA- knockout cell test. To ensure that the auxotrophic *E. coli* did not grow without methionine, the MetA- cells were grown on plates with dropout media that either contained 19 amino acids (excluding methionine) supplemented back into the media or all 20. Figures 3A-3C show the agar plates from this growth test. Figure 3A shows cells grown on dropout media without methionine where, as expected, there was no cell growth. The small circles seen on the plates are air bubbles within the agar. Figure 3B shows cells grown on dropout media with all 20 amino acids, where, as expected, there was cell growth. 3C shows the MetA- cells grown on an LB agar plate for colony phenotype comparison between medias.

Forward Primer:

5'-
GAGGTGGGCCCTTGACATATAGAATACCCCCCTATAGTATATTGCATGCAGATGATG
AGGTGCGAAATGCCGATTCGTGTGCCGGAC -3'

Apa1 Restriction Site

Reverse Primer:

5'-ATTCGCTCGAGTTAATCCAGCGTTGGATTCAT-3'

Xho1 Restriction Site

Figure 5. MetA gene primer design. Both a forward and reverse primer were designed to clone the MetA gene out of the pBAD MetA WT host plasmid. On the forward primer, text highlighted in blue is a part of the frm promoter region. Underlined text in the forward primer is where frmR (the formaldehyde repressor) will bind. In both the forward and reverse primers, text highlighted in red are each primer's corresponding restriction site (Apa1 and Xho1, respectively). Black text on both primers indicate overhangs for the restriction enzymes to sit on top of.

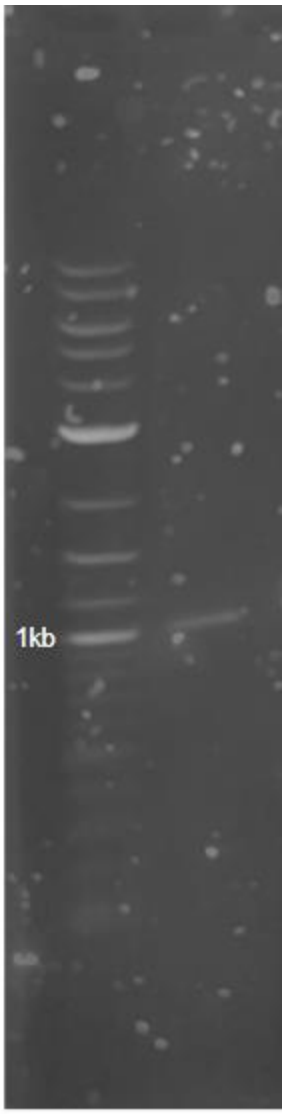

Figure 6. Agarose gel of MetA PCR insert. Through using the designed primers the *MetA* gene of interest from the pBAD MetA WT host plasmid was amplified through PCR. Lane 1 contains a DNA ladder while Lane 2 contains the *MetA* insert. The insert band appears at around 1000 bp, as expected, showing the PCR was successful and *MetA* was successfully cloned.

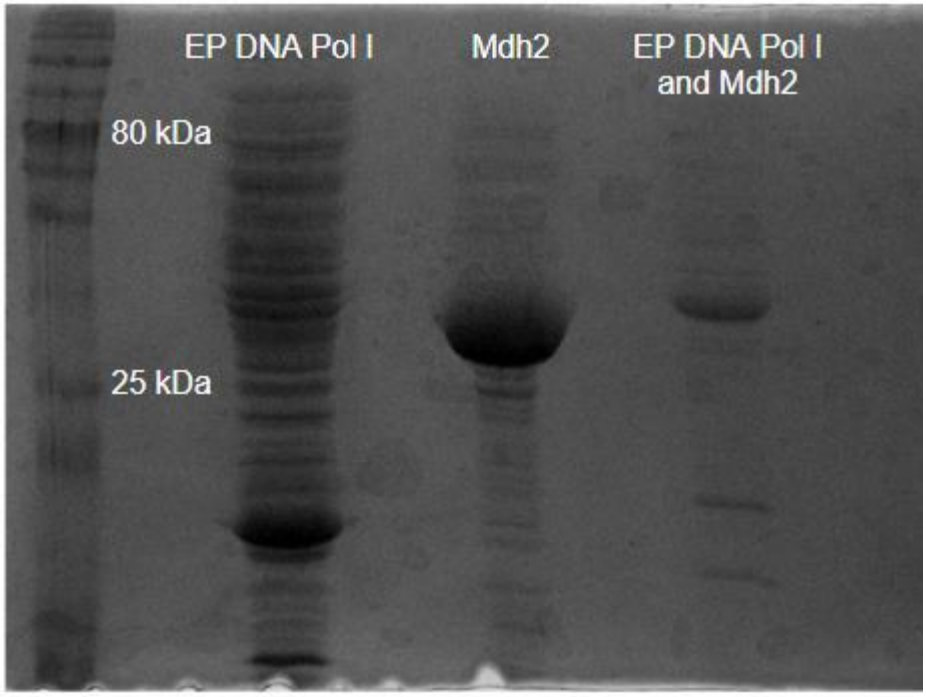

Figure 7. PAGE gel for co-expression tests. Lane 1 contains a protein buffer. Lane 2 contains a sample of protein extract with cells that have been transformed with pEP. A band can be seen in this lane at 15 kDa. Lane 3 contains a sample of protein extract from cells transformed with pMdh2. A band in this lane is seen at 40 kDa. Lane 4 contains a sample with proteins purified from MetA- *E. coli* cells transformed with pMdh2 and pEP. Bands in this lane can be seen at 40 kDa, 15 kDa, and 5 kDa.

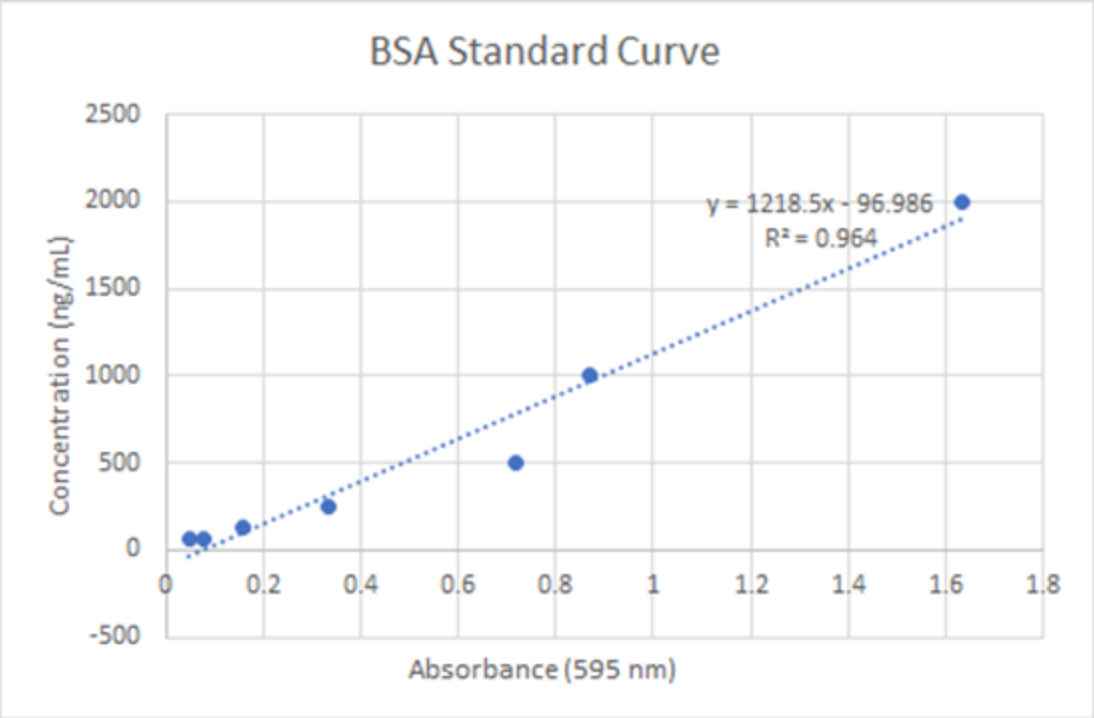

Figure 8. Pierce 660-Assay standard curve.

	1	2	3	4	5	6	7
Standard	1.633	0.871	0.719	0.334	0.158	0.078	0.047
Control	1.329	0.721	0.454	0.156	0.183		
pEP	1.612	1.161	0.705	0.376	0.368		
pMdh2	2.381	1.903	1.512	0.994	1.036		
pEP & pMdh2	2.092	1.897	1.806	1.521	1.591		

Table 1. Pierce 660-Assay OD values corrected for blank measurement.

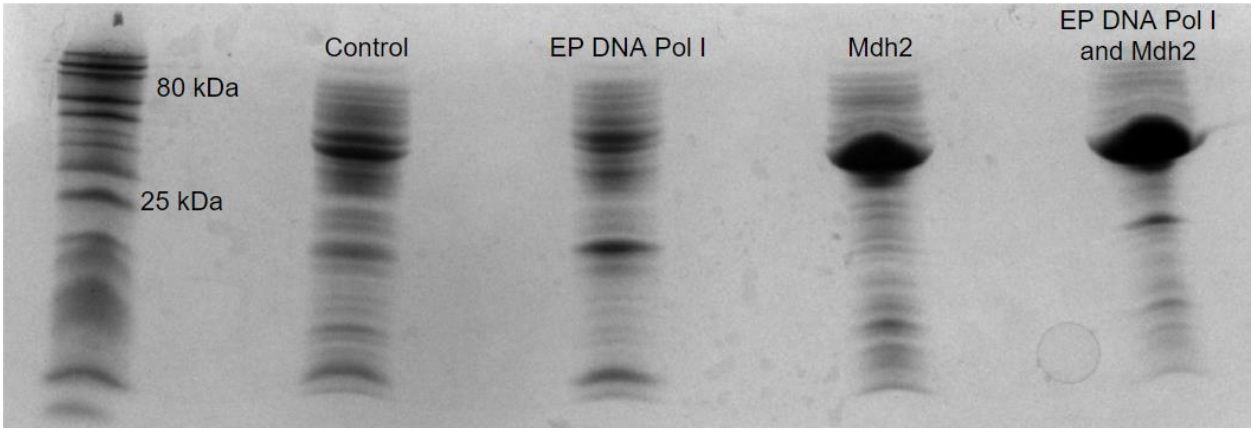

Figure 9. PAGE gels for co-expression tests with normalized protein concentrations. Lane 1 contains a protein ladder. Lane 2 shows a control of only MetA- cell protein extract with no transformed plasmids. Lane 3 contains protein extract of MetA- cells transformed with pEP. ALane 4 contains protein extract of MetA- cells transformed with pMdh2. Lane 5 contains protein extract of MetA- cells transformed pEP and pMdh2. Expected size of Mdh2 and EP DNA Pol on are 40.7 kDa and 109 kDa, respectively. Mdh2 appears at the expected length in both lanes 4 and 5, while EP DNA Pol I appears near 20 kDa.

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Part 2: The Lifecycle of a Press Release

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Abstract

As Worcester Polytechnic Institute has grown in size, the university has been expanding its efforts to improve campus and foster its reputation nationally as a research institution. As such, research at WPI continues grow. As research expands, the volume and complexity of making it known to the public becomes a difficult task as STEM jargon is unfamiliar to the majority of the general public. To help combat this issue, the WPI marketing team is responsible for publishing press releases that focus on research done at WPI in the hopes that it will help attract media attention to the school and support some of WPI's wider initiatives. This part addresses the overall process and hidden details of the lifecycle of a press release, from determining which will make the best stories, the writing and editing process, and what happens once a news agency expresses interest in a particular story.

Chapter 1: Introduction

As WPI continues to grow, in recent years, its institutional goals have expanded. Most apparent is its goal of becoming a higher research focused institution (Dorsey and Duffy, 2019). WPI is starting new academic programs (most recently, starting a neuroscience M.S. program), building new classroom and research space (such as Foisie Innovation Studios and Smart World building), opening new global IQP sites, and developing a global school for students to be able to embark on more than one study abroad experience. With this new growth, research opportunities across campus are expanding rapidly. As research being done by faculty members is published in academic journals, both the researchers and institution want the results of these studies and their implications marketed to the general public as they are proud of the difference they are able to make. However, as more scientific research is conducted every year throughout the country and world, news outlets are flooded with possible research stories that could be of interest to their readers. In addition, the research articles published by academia researchers can be extremely difficult for media reporters to read as they oftentimes do not have a background in the research being done, making the jargon nearly impossible to interpret.

At WPI, the marketing department helps to recognize faculty research through writing and publishing press releases that simplify jargon. Press releases serve as a compelling, short synopsis of important research that cover the work being done, its impact to the world, and the future direction the research can take. With the idea "You innovate. We present it to the world" (WPI, 2019a), marketing team members work with WPI faculty to take their research and published papers and turn them into shorter press releases to draw light to the research being done at WPI. These press releases will then get sent to media outlets and peer universities, as well as appear on WPI's website for anyone interested to view. Through press releases and department efforts, the WPI marketing team aims to "advance the recruitment, reputation, and research of [their] students, faculty, and staff" (WPI, 2019).

Although a press release may look simple upon viewing – it is a short document with a predictable format - its appearance is deceptive. At the university level, due to the volume of research being conducted at WPI, the WPI marketing department has created their own press release selection system to analyze which stories will best translate into effective press releases that will garner media attention, showing that the process marketing takes to write a press release is not only multi-faceted, but goes beyond just a written document. This research paper aims, through interviews, case studies, and literature reviews, to dive deeper into the genre of a press release to highlight what a surprisingly complex genre it is.

Chapter 2: Methodology

The goal of this project was to understand how WPI faculty research is promoted by the WPI marketing department through analyzing the genre of press releases. To complete this goal, the following objectives were pursued:

1. Research how an effective press release is written
2. Understand the WPI marketing department's approach to writing press releases about research done by WPI faculty
3. Determine similarities of press releases at the institutional level
4. Reflect on the process of the lifecycle of a press release

		Objective			
Method		1	2	3	4
Genre Analysis					
1	Best Press Release Practices from Current Reporters	■			
2	WPI Press Releases vs. Peer Univerisites	■		■	
3	WPI Press Release Case Study	■	■		
Interviews		■	■		■
Write a Mock Press Release					■

Table 1: List of project objectives which associated method that was used to complete it.

Section 2.1: Genre Analysis

To get a better understanding of how a press release is written and see similarities and differences between university press releases, I conducted a genre analysis of press releases. Three different types of sources were pursued to compile best practices for writing press releases: online articles written by current media reporters, press releases published by WPI and WPI's peer universities, and a case study of how a press release is developed at WPI.

Section 2.1.1: Writing a Press Release from Current Reporters

When searching for best practices for press releases, I focused on looking at news agencies that are widely known. As I quickly discovered, press releases at WPI are partially written to garner the attention of possible media reporters, so I chose to focus my search on news agencies rather than textbooks, blogs, or scholarly articles. As there is a lack of information regarding this genre, and since media reporters write and read press releases daily, searching for their best practices would prove to be the most useful. To search for such articles, I used search terms such as,

- How to write a press release
- How to write an effective press release
- Elements of the best press releases
- What compels a reporter to pick up a story
- Press release best practices

Two new agencies, *Forbes* and *CBS*, had the most detailed articles and were consulted for best practices from the perspective of a current media reporter.

Section 2.1.2: How WPI Press Releases Compare to Peer Universities

Along with publishing press releases to the WPI website, the Marketing Team will also send them to WPI's peer institutions, which include Rensselaer Polytechnic Institute (RPI), Northeastern, Stevens Institute of Technology (SIT), Rochester Institute of Technology (RIT), Illinois Institute of Technology (IIT), and Case Western. I chose to study press releases from peer institutions rather than media agencies to examine if the genre is consistent across different writers within the academic realm. Since universities write press releases modeled for media reporters so editing is minimal before publishing their news article, it can be assumed that universities write press releases with this same goal in mind. While different writers have varying voices, the goals of a peer university's press release would likely more closely match the goals of a WPI press release than one from the media. Thus, choosing universities would give the best insight into similarities and differences across this genre. In particular, I analyzed articles from RPI and SIT for similarities and differences to WPI's press releases.

The elements of each article that were focused on include:

- Article title
- Article subtitle
- Use of quotes from involved researchers
- Media contacts
- Pictures/visual media content
- Hyperlinks
- Inclusion of grants/funding

Section 2.1.3: Case Study

I was also able to shadow Lisa Eckelbecker, a WPI marketing Content/Research Writer, while she developed a press release done by Shichao Liu, Jacob Whitehill, and Steven Van Dessel on developing classroom environments that promote student learning. The case study was divided into the following parts:

- **Interview with Shichao Liu**: Professor Liu is an assistant professor of architectural engineering at WPI. After Lisa was notified of the grant that he and his colleagues received for their research, she began her press release story by reaching out to and interviewing Professor Liu to get a better understanding of the team's research, future directions, goals, and reasons why this project is important to the WPI community. I was able to attend the hour-long interview with Professor Liu to listen to the types of questions Lisa asked to better understand the information she was looking to gather to include in the press release.
- **Press Release Draft Writing**: After her interview with Professor Liu, Lisa then began to write drafts of the press release. I was given access to the 17 drafts she wrote as well as to the editing comments made by those she asked for feedback from. These drafts were then analyzed to better understand how the press release developed before it was published on

the WPI website. For privacy purposes, comments made on the varying drafts are omitted. I created the following tables to analyze the different drafts:

- Draft Number vs. Title Edits

Draft Number	Title
1	WPI Researchers Awarded Grant to Improve Classroom Environments and Boost Student Learning

- Draft Number vs. Comments Made

Draft Number	Comments	Original
1	None	N/A

- Draft Number vs. Person Draft was Sent to for Edits and Comments

Draft Number	Commenter
4	Public Relations

- **Media Attention**: After the press release was published on the WPI website, a few days later, Mark Travers, a contributor for *Forbes*, wrote a report about the research done and published it on the *Forbes* website. The article can be found here. I compared the original press release written to the article written by Mark by analyzing for:
  - Are the quotes included in the *Forbes* article the same as those included in the original press release?
  - Was any part of the body of the *Forbes* article a direct copy and paste from the original press release?
  - Which parts of the press releases did the *Forbes* contributor deem to be most important to write about?
- **Email interview with Forbes contributor**: After analyzing the article written by Mark, I interview him via email about the article he wrote. The following questions were asked in an email interview:
  - How did you hear about this learning environment story and the research being done at WPI?
  - What made you interested in this story?
  - In general, how do you go about choosing what stories you want to write about?
  - There were a lot of quotes that you used in your article. Other than the press release from WPI, how were you able to get these additional quotes? What is the purpose of including multiple quotes from the researchers involved?
  - How long do you think it took you to write this article (from the time that you heard about the research/reading the press release to publishing the article on the Forbes website)?
  - What do you think are some of the key elements of an effective and eye-catching press release?

Section 2.2: Interviews with the WPI Marketing Team and WPI Researchers

While researching press release best practices, I also reached out to various members of the WPI marketing team to interview them further about how a press release is written, to understand how WPI approaches writing press releases based on faculty research, and to gather enough information to write my own press release based on my biochemistry MQP.

Section 2.2.1: Interviews with WPI Marketing Department Members

To get a better understanding of the press release process at WPI, content writers, public relations team members, and strategic communications team members were interviewed.

- **Content Writers**: Lisa Eckelbecker was the WPI marketing Content/Research Writer that was interviewed as a part of this project. Interviews with Lisa served to understand how she decided which research stories would develop into a good press release, the process of how she writes a press release, and what happens to the press release after it is published.
- **Public Relations**: Andrew Barron was the Public Relations team member that was interviewed as a part of this project. The interview with Andy helped to understand how media outside of WPI hear about the university's press releases, what happens to a press release once it is published, what types of stories grab the media's attention, and how the media decides if they want to pursue a story.
- **Strategic Communications**: Alison Duffy was the Strategic Communications team member that was interviewed as a part of this project. Interviews with Alison helped to understand the flow of a press release, from initial idea to final product, challenges when writing and publishing a press release, and how to convince the media that a press release is a marketable story.

Section 2.3: Writing a Mock Press Release

As a culmination of all of the information I gathered through online research, interviews, and the case study, I wrote a mock press release of the Biochemistry side of my joint MQP to reflect on this process. Writing a press release allowed me to take this knowledge and see if someone who was once unfamiliar with the genre could use these best practices to write a press release based on lab research. Along with using these best practices to write the document, I also contacted my Biochemistry MQP advisor, Dr. Destin Heilman, and MQP partner, James Andon for quotes to include. Following writing an initial draft, I send the press release to both my Professional Writing major advisor, Professor Madan, and Lisa Eckelbecker for comments to better understanding the editing process. Based off their suggestions, I wrote a final press release draft.

Chapter 3: General Best Practices of Writing a Press Release

From completing a genre analysis, interviewing and shadowing WPI Marketing team members, and writing a mock press release, I found that press releases are a surprisingly consistent genre. Since every writer has their own individual voice and each press release covers extremely different topics, I had originally expected them to look and sound different. However, it quickly became apparent that not only do press releases have the same formal features, but all use the same factual tone to quickly and efficiently explain to the reader the ongoing research while trying to show the greater impact the research has on the world. The following chapter details the general best practices of writing a press release.

Section 3.1: Press Release Main Components: At a Glance

The genre of press releases is surprisingly consistent, from its overall appearance down to the content it aims to include. Press releases contain both titles and sub-titles to engage the reader and to capture a potential media reporter's attention to convince them to read the article, which generally shorter than two pages. Each devotes a section to media contacts to make it simple for a reader to contact the assigning PR team member. They contain pictures to further engage the reader and explain the subject at hand and are full of quotes pulled from researchers to give the article a human touch.

Overall, press releases serve as a function of free advertising for marketing departments. They are short documents that give a high-level overview of a story, whose main purpose is to convince a reporter why a story is compelling and that they should follow the story, dig deeper, and report on it. These short pieces are often published online on a marketing department's web page or sent to news outlets for publicity (Duffy, 2019).

Section 3.1.1 Goals of Press Releases

The ultimate goal of a press release is to convince a reporter why they should care about a particular story and why they should pursue covering it. Since reporters often get hundreds of emails a day, a public relations representative may only have a few words to convey why a research topic is important, so press releases serve as a compelling, short synopsis of important research that cover the work being done, the impact to the world, and the future direction the research can take. Through these press releases, reporters can quickly decide if a story will be of interest to their readers.

In addition to functioning as a tool of persuasion, press releases also serve as documents of record. Those that are focused on research topics are generally heavier on technical terms, so they need to serve as a factual piece. The goal of these press releases are to give the reporter a solid foundation on the research topic at hand and to function as a non-partisan document. After a media reporter reads a press release, they should not need to look up definitions to jargon that was used in the document. Rather, the writer of the press release purposely uses simpler terms or provides fleshed out definitions, so the reader is able to understand the press release without needing a background in the associated subject (Dorson and Duffy, 2019).

Section 3.1.2 How a Press Release is Written

Since a press release's ultimate goal is to convince a reporter to pick up a story, press releases from different universities not only have similar appearances, but use similar tactics to achieve this goal. Even though there is a focus on specific elements a press release should have, each should be treated as a means of marketing a story.

According to Robert Wayne, a former *Forbes* contributor, the four basic elements of a press release are its headline, opening sentence, body, and contact information. Writers should focus on "writing[ing] a short, catchy headline, get[ting] to the point [by] summariz[ing] your subject in the first paragraph, and [crafting the] body [by] mak[ing] it relevant to your audience" (Wayne, 2016).

The subject headline: Out of these features, this is the most important as if it is not catchy, a reporter will not be apt to open it. The headline should get to the point quickly and tell the reporter why they should care and what the story is.

Get to the point: Tell the reporter what the story is about but avoid repeating the header.

The Body: The body is where the information given in the headline should be expanded on. The language used in the body should be simple and easy to understand, especially if the subject is a tense topic (Wayne, 2016).

In addition to focusing on main writing aspects of a press release to get a reporter to invest in a story, press releases also have overarching themes that should be incorporated. Geoffrey James, a writer for CBS News, has five rules for press releases:

1. Use the press release as a sales tool by communicating your idea to "customers"
2. Have a newsworthy story by being sure to convince the reporter why your story is important
3. Write the press release like a reporter would write it. By making the article look like a news story, the reporter will only need to do minimum editing to publish it
4. Provide some good quotes
5. Contact top outlets personally (James, 2010)

From these reporters, it can be concluded that creating a compelling story is absolutely essential to a successful press release. The writer needs to make the reporter care so they will want to pursue the story. While there are "best practices" that a writer can follow while composing a press release, it is up to the reporter to determine which elements they will focus on to create a compelling, marketable story.

Section 3.2: Consistency of Press Releases in Academic Settings

To further understand how WPI's press releases are written, I compared WPI press releases to peer universities' press releases to analyze their similarities and differences. For this comparison, I looked at WPI compared to RPI and SIT. Table 2 below shows the comparison between the three schools, with WPI acting as a baseline.

	WPI	RPI	SIT
Content Writer and Media Contact are included in the press release	x	x	
Relevant, captioned picture is placed at the start of the article	x	x	x
Body of press release contained additional picture/media content	x		
Press release had multiple quotes	x	x	x
Includes a subtitle under the press release's main title	x	x	x
If research was funded by a grant, grant amount and donor were included	x	sometimes	x
Press release ends in an "about the university" section	x	x	x

Table 2: Comparison of WPI press releases to RPI and SIT press releases (Dorsey, M, 2019a,b, Gaudin, S, 2019a,b, RPI, 2019a,b,c, SIT, 2019a,b, and WPI, 2019b)

Overall, the press releases from all three schools were shockingly similar, with the main difference being that WPI was the only institution to include further visual media in the body of the press release. Media that supports an aspect of the research being explained in the press release will help the reader to get a better understanding of what is being researched, which could make them more interested in a story, or in some cases, to attend the school that the press release was written by (Dorsey, 2019a,b, Gaudin, 2019a,b, RPI, 2019a,b,c, SIT, 2019a,b, and WPI, 2019b).

The other element that both WPI and SIT always included, but not RPI, was grant amounts and donors if the research was supported by one. RPI's press releases were a mix of inclusion and exclusion. However, WPI press releases tended to include exact dollar amounts of grants while RPI and SIT included rounded, whole numbers. Including grants gives credit to the funding agency in the hopes that they will fund future projects as well as shows prospective students that a university receives funding for research. Since a limited number of articles were analyzed, the ones I had chosen from RPI just may have happened to not put emphasis on grants, making it possible that the majority of other articles do (Dorsey, 2019a,b, Gaudin, 2019a,b, RPI, 2019a,b,c, SIT, 2019a,b, and WPI, 2019b).

Even with these differences, the similarities between the press releases prove it is a consistent genre at the institutional level. They aim to include the same information and have a similar layout to make it easy for readers to gain knowledge and for media reporters to exert minimal effort in understanding and editing what they are reading (Dorsey, 2019a,b, Gaudin, 2019a,b, RPI, 2019a,b,c, SIT, 2019a,b, and WPI, 2019b).

Chapter 4: Structure and General Life Cycle of a WPI Press Release

After researching general best practices of press releases from current news reporters and talking to members of the WPI Marketing Team about why press releases are written and the overall goals in writing them, I wanted to learn more about how a press release is written at WPI. While there may be general best practices for writing press releases, understanding how these are used at WPI allowed me to gain a deeper understanding of this process as well as put this research into context. Since it was clear that a press release is more than just a written document, I interviewed additional members from marketing to understand how a research story is chosen for a press release, the drafting and editing process, as well as what happens to a press release post-publication. Beyond just understanding the overall picture of a press release, these interviews allowed for investigation into how a research story at WPI comes from being inside of a faculty's research space to being released to the media and the public.

When deciding which research story will be pursued, the Marketing Team looks for four main criteria:

1. If the research was funded by a grant
2. If the current research could attract further funding for WPI
3. If the research supports some of WPI's university-wide initiatives
4. If the research targets current public interests.

This chapter discusses where the marketing department receives information about research being done on campus as well as the key marketing personnel in the lifecycle of a press release (Bogdan, 2019).

Section 4.1: WPI Marketing's Sources of Press Releases

Figure 1 shows the six main areas from which the WPI marketing department receives information about research being done at WPI that could become press releases. With the vast number of research projects occurring at WPI daily, it is impossible for the marketing department to report and create a press release about every one of them. It is important that they have a method to choose which research stories will best garner media attention as well as which will best help support WPI's yearly initiatives. By identifying specific groups that they can hear about possible press releases from, their search is not only more limited but brings stories that they absolutely must report on (such as research that receives a large grant) to the forefront. This section details the different sources the marketing department gets press release tips from to better understand not only which types of stories they deem as most important and most marketable, but also to understand the early beginnings of the lifecycle of a press release at WPI.

Since there are so many sources for possible press release topics available to marketing, the team will also meet every week to discuss possible stories to follow to determine which will be pursued.

Figure 1: Sources that the WPI marketing team use to gather information about possible press release topics. In addition to gathering possible topics to pursue from these sources, stories of interest are also discussed at weekly team meetings.

Supporting WPI initiatives through attracting new faculty members and undergraduate/graduate students

One of the main goals of WPI is to attract new faculty to the university as well as recruit undergraduate and graduate students. Multiple press releases sources in Figure 1 contribute to this goal. WPI's Office of Sponsored Programs (OSP) receives a daily report of every grant or funding award a research project is given, which they then send to the marketing department. By pursuing stories that received money from an outside source, it shows potential faculty members that WPI receives outside funding, which they could receive for their own personal research. It also helps attract graduate students as it proves that WPI labs have funding to support graduate research and stipends.

The Marketing Team will also pursue stories after a faculty member's research has been published. In particular, they look for research that has been accepted into prominent journals like *Nature* and *Science*. Highlighting published faculty research helps support the university goal of attracting more students and faculty members. As students and potential faculty members conducting research want their research to be eventually published, seeing that WPI has research

presence in well-known journals will show potential students and faculty that they could have a chance to also be published in these publications.

Current public interests and trends are also excellent sources for press release topics. Most often, people read about what they are interested in, so timely current events (such as climate change or the fires in Australia) are another drive for press release topics. This helps support the WPI initiative of attracting prospective college students to WPI. By writing about current events, it is more likely that the press release will appear on a search engine since people are more frequently looking up search terms related to the hot topic. If a WPI press release appears on a search engine page as a result of a student looking up a current event, they can not only see that WPI is involved in relevant research, but WPI as a possible university to attend appears on their radar.

Reporting on new WPI initiatives lend towards supporting this goal as well. This shows prospective students and faculty members that the university is evolving through starting new programs and expanding on opportunities. By opening up new programs, WPI will need new faculty to support them, and new programs leads to more potential academic concentrations to prospective students.

Getting University Funding

Another goal that marketing has when looking for press release topics is getting more university funding. Similar to attracting new students and faculty members to the university, multiple press release sources have the goal of attracting funding to the university. For example, research stories from the OSP help support this goal. Highlighting research that comes out of a grant or outside funding source gives publicity and credit to the funding agency, making it more likely that they will pursue further partnerships with WPI. In addition, press releases about research published in esteemed journals highlight impressive discoveries, which could make agencies more likely to award more grants to WPI research.

Promoting new WPI initiatives to expand the university also helps support this goal. This shows funding agencies that WPI is constantly bringing new programs, and thus, new research opportunities, to the school, giving the agencies more opportunities to support various research. This also opens the possibility for them to donate money towards the initiative, such as helping to build one of WPI's newest buildings, Smart World.

Attracting Media and Public Attention

Overall, all of the press release sources ultimately aim to attract media and public attention as the hope is for these press releases to either be read or reported on by major media outlets. However, two sources particularly support this goal.

WPI's Vice Provost of Research, Dr. Bogdan Vernescu, is a possible source for press release topics that especially helps support this goal. Dr. Vernescu meets biweekly with the Marketing team to discuss current research at WPI that has the possibility to become an attractive story to the press. Dr. Vernescu not only supervises research done at WPI but also helps compile research newsletters that WPI publishes. Stories that are featured in these newsletters are likely press-release worthy and would appeal to variety of different people since these letters are distributed

to families, academic institutions, and to other WPI contacts (Vernescu, 2019). In addition, these newsletters are sent to universities across the country, helping to increase WPI's reputation.

WPI faculty researchers are another resource available to marketing that appeal to this goal as they are the most involved in their respective research. Faculty members that are working on interesting research oftentimes want their research highlighted to the public and, since they are so personally involved, have the best understanding of why the research is important, what its greater implications are, and why they decided to pursue this particular topic. Researchers give press releases a humanizing element, so learning about possible stories from them help the marketing department appeal to both the media and public's emotional sides.

Overall, identifying the best places to obtain compelling research stories supports Geoffrey James' second rule for press releases: to have a newsworthy story that a reporter will be convinced is compelling. If the marketing department were to write press releases on every research project being done at WPI, they would saturate the market and truly compelling stories would get lost. Identifying the best places to look for stories will help ensure they are writing about relevant, interesting content that a media reporter will be more likely to pursue.

The number of possible press release sources show that, any given moment, there is no lack of possible topics. WPI, as well as other universities and news agencies, can only publish so many articles at one time, so it is important that they be picky about which stories they choose to pursue. It was interesting how deliberately each press release was chosen to ensure that it supported a WPI goal, convinced news agencies to pick up the story, or proved to simply be a groundbreaking research project.

Section 4.2: WPI Marketing Team Layout and Functions

Once a press release topic is decided upon, different Marketing Team members play different roles in the lifecycle of a press release. Figure 2 outlines the different personnel involved in the press release process and their roles.

Figure 2: Layout of the different WPI marketing teams that are involved in the development and post-publication of a press release.

A press release topic will first go to marketing's content writers. The various content writers within marketing are assigned groups of WPI's majors, which determines which press releases each will cover. They are responsible for helping to identify compelling stories, interviewing the faculty members involved in the research topic, and writing the final press release with help from various marketing team members. Before a press release is published, the digital and visual marketing departments help to create visuals that will be embedded in the press release. Once a press release is published, the public relations department takes over the press release as it moves into a post-publication media marketing phase (Eckelbecker, 2019).

The public relations team is responsible for pitching press releases to the media, generating media interest, and, along with strategic communications, preparing WPI researchers for interviews they may have if their story garners attention. When a PR member creates a media pitch for a reporter to generate interest, they aim to talk about and sell a story in 15 seconds. The pitch needs to be quick, but also cohesive and articulate so someone unfamiliar with the research can understand its impact. Once media interest is generated in a press release, the PR team will switch to preparing the faculty researcher for interviews (Baron, 2019).

During interview prep, the main goal of the PR team member is to help the faculty member develop key messages about their research by going through a 30-40 minute messaging exercise

with them. From this exercise, the researcher will develop three main messages they can take to an interview:

- A problem/solution message
- A fact/result message
- A benefits message

Since interviews are quick and reporters are generally interested in the overall why of the research, it is important that the faculty member goes into the interview knowing what they want to say in an understandable and accurate manner, especially since the reporter isn't an expert in the associated research. In addition, as suggested by Geoffrey James, it is important for a press release to include good quotes. If the interviewer plans to write a press release following the interview, preparing answers to anticipated questions will help the researcher give the reporter good quotes to use. The problem/solution message should succinctly explain what the research addresses and how it will help solve this problem. In the fact/result message, the researcher should be able to quickly communicate what problem their research addresses and what the intended solution for the problem their research will create. This message will then further describe the result of the research and what it was able to accomplish. The benefits message will address how the research was able to contribute towards solving the problem and why it was an important project. After developing these messages, the PR member then reviews possible interview questions that a reporter could ask and helps the researcher develop answers to them. An example interview prep sheet for an athletic shoe research project can be found in Appendix A (Baron, 2019).

Section 4.3: WPI Press Release Drafting Process

Once a research story is identified as press release worthy and a content writer is assigned to the case, the press release drafting process begins with some preliminary work. The content writer will read any publications written by the researchers that currently exist (e.g. a grant proposal or journal article). The content writer will also schedule an interview with the researcher to learn more about their research, why it is important, and the impact it will have. Additionally, this will provide the content writer with quotes to include in the final press release.

Following these background steps, the content writer will begin to write the first draft of the press release. After writing this first draft, it will go through a series of edits and revisions, which are outlined in Figure 3 below.

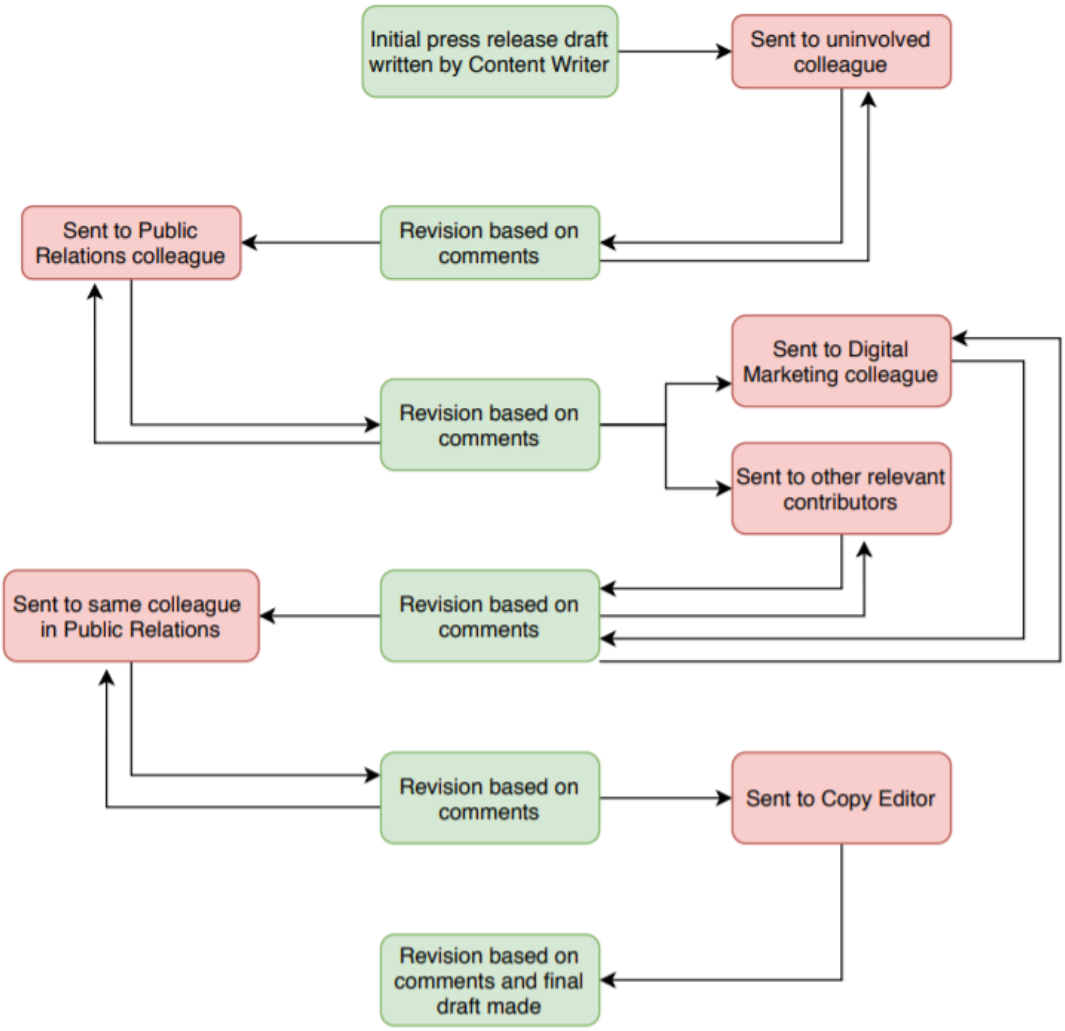

Figure 3: Flowchart of the drafting process of a press release. Red bubbles signify that the draft is sent to a colleague for comments and green indicates a revision step.

This flowchart shows both the flow of press release draft to commenter as well as shows the back and forth that can occur between the content writer and commenter. After writing an initial draft, the content writer will send it to a marketing colleague who is completely uninvolved in the story. This colleague has no background in the research being done and, aside from what they may have heard at meetings or around campus, does not know what the article was about to prevent reader bias and to ensure a person unfamiliar with the research can understand the press release. In addition, if the colleague finds the press release boring, then it is likely a media reporter will too. As previously mentioned, it is important to have a newsworthy story in order to convince a reporter that it should be covered. This first editing step will help ensure that the press release is interesting, eye catching, and will catch a reporter's attention.

After getting an outsider’s view, the comments from the colleague are taken into consideration and a new draft is written by the content writer. The new draft is then sent to a colleague in public relations. The comments made on this draft will help hone the marketability of the article

to a media outlet. Honing marketability will ensure that the WPI press release is written like a media reporter would write it, thus helping them have to make minimum edits and changes in order to publish the article.

The content writer will then write another draft based on these comments, which can then be sent out to different people depending on the topic of the article: a digital marketing colleague and/or any other relevant contributors, like the faculty researchers. The goal of asking the WPI faculty working on this research for comments and edits is to ensure that the content writer did not misunderstand the project as well as to ask for more quotes to include in the press release that speak to the researcher's perspective. It is imperative that each sentence written in a press release is accurate, so the reader is not left confused after reading a press release. These quotes will also help make the article more personable as well as accountable so the reader can see the words are coming directly from the research rather than being a summary from the content writer.

A hidden step in the press release process that is not visible in a final draft is sending a draft to a digital marketing colleague. Their job is to identify key search terms, phrases, and questions that someone interested in the research topic might type into a search engine. Once these are identified, they are sent to the content writer to be included, if possible, into the press release. By including these key terms, it boosts the likelihood that the WPI press release will appear at the top of an engine search. Not only does this increase the chances of a reporter clicking on the article but also of someone interested in the research topic to be directed to the press release and thus the WPI website. This helps support the university's goal of continuously trying to recruit new undergraduate and graduate students. If a prospective student happens to see the article online, it could spark their own interest in attending WPI or learning more about the university. This small detail of search engine terms can really boost an article's visibility and was a very surprising step.

Another draft is written based on this grouping of comments and sent it back to the same public relations colleague for a final article substance edit to ensure that the overall message and importance of the research had not been lost in subsequent edits. After incorporating these edits, the content writer sends the final draft to a copy editor for final grammatical edits. Grammatical edits are made and then the final press release is ready to be published on the WPI website.

Section 4.4: WPI Final Press Release Checklist

Prior to publishing the final press release on the WPI website, the content writer completes a Press Release Checklist. This checklist does not only include the actual press release but also other information that the marketing department will use to market the story and upload it into content management systems effectively.

The content writer needs to create both a long and a short headline for the article. The long headline is the one that will be published as the title of the press release while the short headline will be used on webpages and other sites that do not have the word space for the longer headline. The content writer then decides on a single quote from the press release that can be used for social media marketing as well as includes final media images and hyperlinks into the final press release.

Another part of this checklist is information about the article that will be inputted into Drupal, the content management system used by WPI marketing. Drupal helps in reaching different media outlets that could be interested in the press release through multiple online channels. The most important information that is included are the different tags the article will be given in Drupal. Adding tags to articles make them easier to find and search, similar to the function of the phrases identified by the digital marketing colleague for inclusion into the press release.

The final part of the checklist is including the various WPI website pages the article should be published on. For example, press releases are generally published to the WPI news page as well as to department webpages.

After completing this checklist, the final press release and checklist is sent to a member of the marketing department who will support the press release. In addition to these two elements, the email the content writer sends with the press release also includes captions for any photos embedded in the article as well as proposed tweets for Twitter. The proposed tweets will be used once the article is published to promote it on social media platforms, as Twitter is one of WPI's most widely visible platform.

Section 4.5: Post Publication Marketing

Shortly after the press release is published, it moves onto the public relations department for media marketing and is inputted into Drupal. Figure 4 shows the flowchart of a press release post publication on the WPI website.

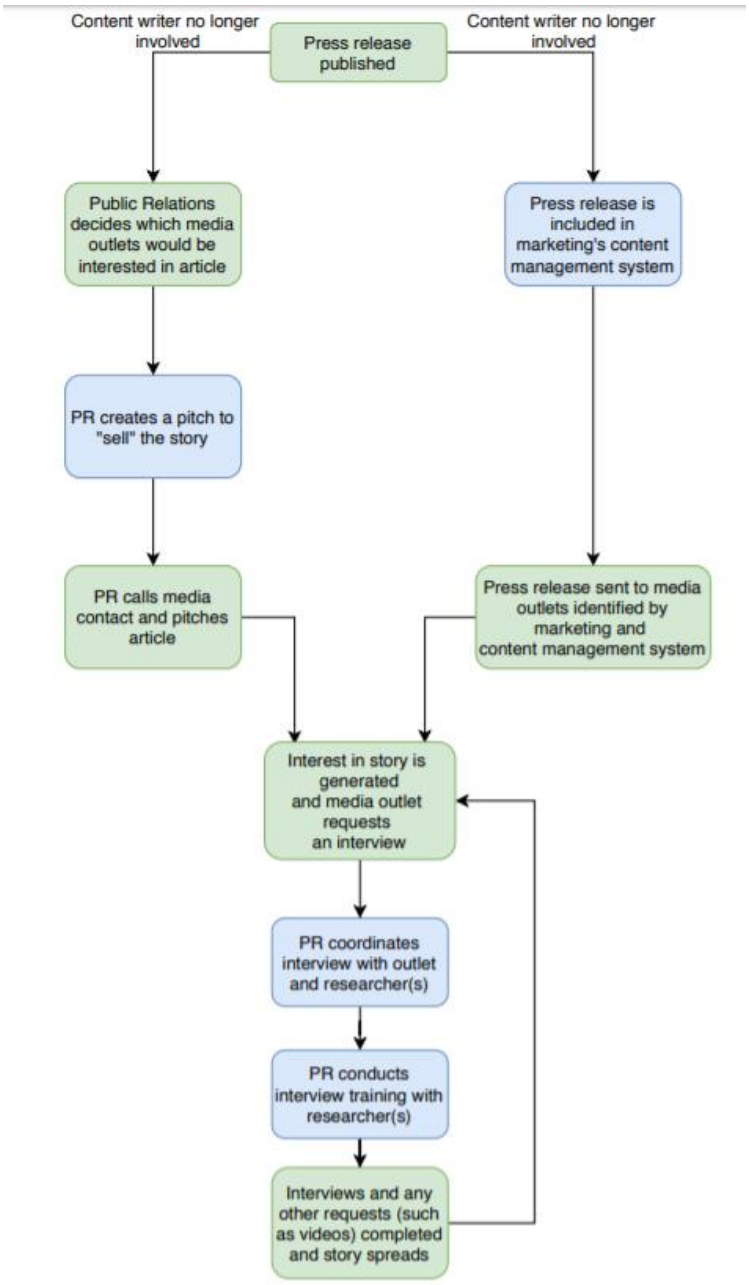

Figure 4: Flow chart of post press release publication marketing efforts. The press release can either be verbally marketed to media through the PR team or through using a content management system. These marketing efforts hopefully lead to media news articles.

After the content writer is no longer involved, the press release is marketed to the media in one of two ways. The first is its inclusion in Drupal, the content management system previously discussed. The press release checklist includes all the information needed to upload the article to Drupal. Once it is uploaded to Drupal, the system identifies media outlets and other media centers that could be interested in the article's topics. Drupal then sends the press release to those media outlets in the hopes that someone will pick up the article and pursue media coverage on the press release.

In addition to Drupal, the public relations team also gains control of the article after it is published. Since many of the public relations team members have their own media contacts, they will identify who might be interested in the article's topic. Public relations will then work to develop a pitch to "sell" the story to identified media. This pitch will give the personal touch that Geoffrey James suggests in his fifth rule for press releases: to contact top outlets personally. This shows that the PR member took the time to consider which of their contacts might find the article interesting. It can also make it more likely that the media reporter will pursue the story since they did not have to sort through emails and news to find a press release; it was presented to them. Once they have a set pitch, the public relations team member will call the identified media personnel and sell the article to them in the hopes that they will decide to pursue media coverage on it.

No matter if media attention is gained through personalized phone calls or Drupal, once interest in generated in the article, the media outlet may decide to write their own press release about the research to publish on their website and could contact the assigned WPI press release PR contact to request an interview with the WPI researchers. The assigned PR member will coordinate the interview and conduct the aforementioned interview training with the researchers, who will then complete the scheduled interview. Hopefully, as more media report on the press release, the research story will spread to other outlets, and further interest will be generated in the story.

Chapter 5: WPI Marketing Press Release Case Study

Chapter 4 introduces the layout and framework of a press release at both the written and behind the scenes levels. It shows the number of people involved in the process, how a story is identified, what criteria a press release looks to fulfill, and what happens to a press release after it is published. In addition to understanding the overall process, I performed a case study based on an individual press release to see how the different dynamics presented in Chapter 4 would affect how a content writer composes and revises a press release, how it is circulated to the media, and how it is ultimately used as a marketing tool. I was able to shadow Lisa Eckelbecker, a marketing content writer, as she developed a press release on research being done to create optimal learning environments for students. Solely understanding the process in the abstract did not emphasize the differing roles within marketing. In addition, following a story allowed me to see what happens to the press release once it is picked up by a media reporter, giving insight into how an institutional press release differs from a media report. Shadowing Lisa gave me insight into her thought processes behind drafting and editing a press release, how to take a scientific topic and translate it into simpler terms, and the steps that are taken throughout the press release process to get a media reporter to write about the story. This particular press release, entitled Not Too Hot, Not Too Cold: WPI Researchers Awarded Grant to Find Just the Right Classroom Environment for Learning, involved three WPI faculty members: Professor Shichao Liu (architectural engineering and the principle investigator), Steven Van Dessel (computer science), and Jianshun Zhang (mechanical and aerospace engineering).

Section 5.1: Information Gathering

After being assigned to this research story, Lisa was given access to the research proposal that these three professors wrote. This research started as a result of a $10,000 seed grant the researchers were given, but they eventually applied for and received a larger grant of over $200,000 to continue their research. Lisa was able to read the research proposal and grant application to better understand the research they were doing.

In addition to diving deeper into the research, she scheduled an interview with Dr. Liu, which I shadowed. The purpose of the interview was for Lisa to learn more about Dr. Liu's research, understand the impact of his research, ask any clarifying questions she had, gather pertinent quotes, and learn how it could impact the WPI community. The interview lasted about an hour. Lisa also asked for Dr. Liu's permission to record the interview so she could later write an interview transcript to take quotes from or ensure accuracy of the press release. Throughout the interview, Lisa and Dr. Liu had a conversation about the background as to why he and his colleagues chose to pursue this topic, what they had completed thus far and their future plans, and how WPI undergraduates/graduates would be involved in the research.

Section 5.2: Press Release Drafting

Based her initial interview with Dr. Liu, Lisa wrote an interview transcript and, along with the researchers' grant proposal and various supplemental information, began to write the first draft of this press release. After writing her draft, Lisa followed the drafting process shown in Figure 5 for comments and edits. For this article in particular, a total of 17 drafts were written over the course of two weeks. I received permission to view these to analyze how the article wording and

content changed depending on who the editor/commenter was as well as what types of comments different colleagues included. Viewing the drafts also demonstrated the back and forth between writer and editors. For privacy purposes, actual comments made on the drafts will be omitted from this analysis, but below are charts that were generated based on the different drafts to analyze how this process works.

Section 5.2.1: Press Release Commentators

As Lisa underwent the press release drafting process, the colleagues she sent her drafts to for edits and comments resembled the flowchart shown in Figure 5, pictured again below.

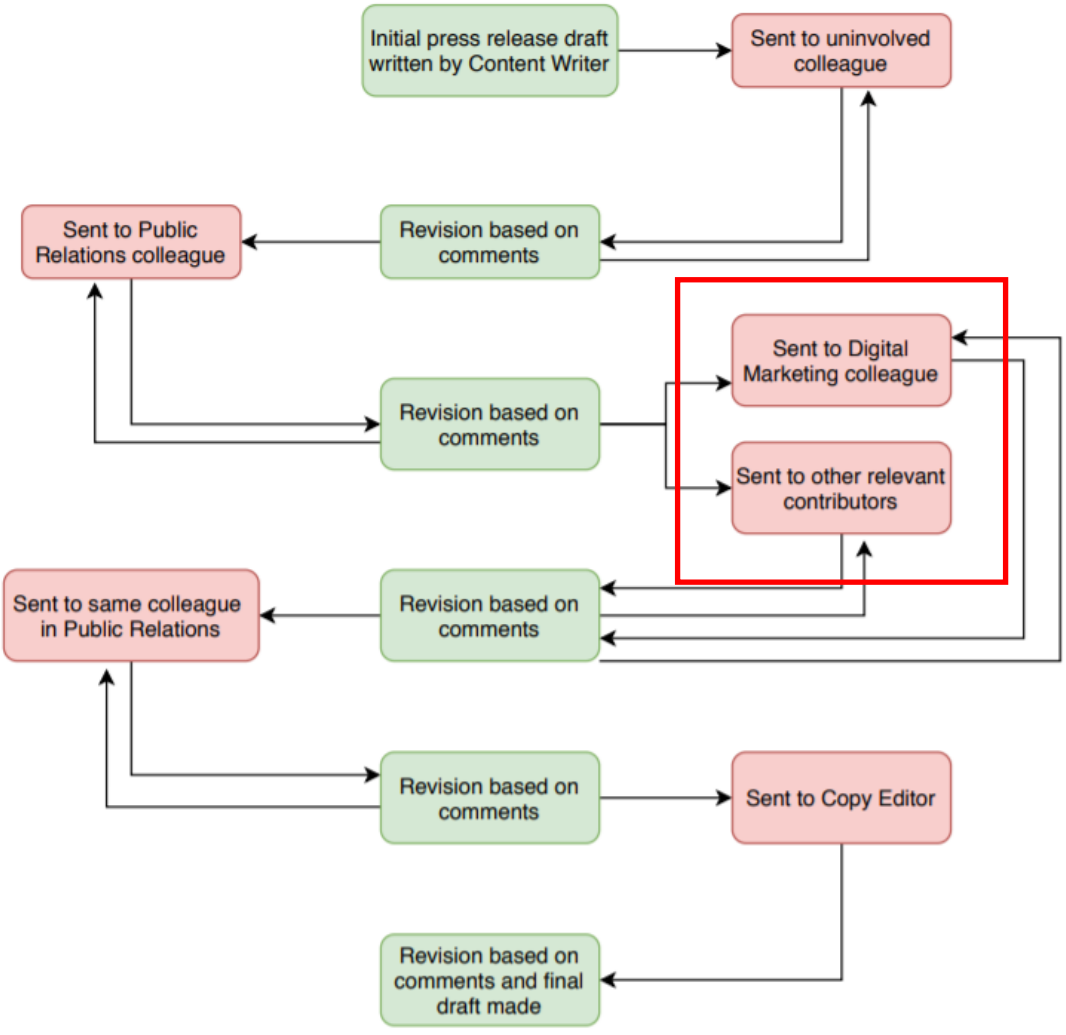

Figure 5: Flowchart of the press release drafting process with specific commenting steps pertaining to this press release highlighted.

Aside from the step highlighted in the red box, Lisa's comment and editing process exactly matched the one outlined in the figure. As this is a generalized figure, the main difference for

Lisa's article were the people she sent drafts to at the step in the red box. Along with sending a draft to a colleague in digital marketing, she also sent it to Dr. Liu, Dr. Whitehill, and Dr. Zhang, the main researchers involved. She also sent a copy to the Vice Provost of Research, Dr. Vernescu. The goal of asking the WPI (Dr. Liu and Dr. Whitehill) and Syracuse (Dr. Zhang) faculty working on this research was to ensure that she did not misunderstand the project or write something misleading as well as to have them each include a quote in the press release about their perspective on the research. Including quotes gives the article a more human and personal touch since quotes come directly from the researchers that are extremely passionate about the research they are doing. Sending the article to the Vice Provost of Research is not always done, but since this press release was about research that would be implemented into WPI's newest building, Smart World, having Dr. Vernescu comment would not only emphasize the importance the university is placing on this research but also how the research will affect the WPI community and, possibly, other universities across the country who are looking to also optimize learning environments. More broadly, having WPI executives comment on faculty research shows that the entire community, from student researchers to research directors, are involved and interested in WPI research. The promotes the idea that WPI is an integrative community where people across all university facets care about what is being done to help change the world.

Section 5.2.1.1: Important Edits and Comments

In Lisa's article, there were two main edits that I found to be most interesting: changes to the title, recommended by an uninvolved colleague, as well as search engine recommendations made by digital marketing. As previously highlighted, the main goals in editing the title are to make it eye-catching and to develop it into a statement that will grab the media's attention and convince them that the article is important. The comments made by the digital marketing colleague truly affected the entire article, from the title and subject headline to the body of the article as Lisa made an effort to include relevant search terms wherever possible. The following sections discuss in further detail the edits and comments made on the title and by digital marketing.

Section 5.2.1.1.1: Title Edits

A major change to Lisa's press releases throughout the drafting process was revisions to the title. As discussed previously, it is important for a title to be eye-catching as well as to effectively tell a media reporter what the article's story holds. A good title will not only tell the report why they should care about the article, but also help the press release become a sales tool that can be "sold" to media reporters as the title is the first impression they receive of the article. Table 3 below gives a summary of the title changes throughout the drafts, with changes highlighted in red.

Draft Number	Title
1	WPI Researchers Awarded Grant to Improve Classroom Environments and Boost Student Learning
2	WPI Researchers Awarded Grant to Improve Classroom Environments and Boost Student Learning
3	**Not Too Hot, Not Too Cold** - WPI Researchers Awarded Grant **to Find Just the Right Environment for Learning**
4	Not Too Hot, Not Too Cold**:** WPI Researchers Awarded Grant to Find Just the Right Environment for Learning
5	Not Too Hot, Not Too Cold: WPI Researchers Awarded Grant to Find Just the Right Environment for Learning
6	Not Too Hot, Not Too Cold: WPI Researchers Awarded Grant to Find Just the Right Environment for Learning
7	Not Too Hot, Not Too Cold: WPI Researchers Awarded Grant to Find Just the Right Environment for Learning
8	Not Too Hot, Not Too Cold: WPI Researchers Awarded Grant to Find Just the Right Environment for Learning
9	Not Too Hot, Not Too Cold: WPI Researchers Awarded Grant to Find Just the Right Environment for Learning
10	Not Too Hot, Not Too Cold: WPI Researchers Awarded Grant to Find Just the Right Environment for Learning
11	Not Too Hot, Not Too Cold: WPI Researchers Awarded Grant to Find Just the Right **Classroom** Environment for Learning
12	Not Too Hot, Not Too Cold: WPI Researchers Awarded Grant to Find Just the Right Classroom Environment for Learning
13	Not Too Hot, Not Too Cold: WPI Researchers Awarded Grant to Find Just the Right Classroom Environment for Learning
14	Not Too Hot, Not Too Cold: WPI Researchers Awarded Grant to Find Just the Right Classroom Environment for Learning
15	Not Too Hot, Not Too Cold: WPI Researchers Awarded Grant to Find Just the Right Classroom Environment for Learning

16	Not Too Hot, Not Too Cold: WPI Researchers Awarded Grant to Find Just the Right Classroom Environment for Learning
17	Not Too Hot, Not Too Cold: WPI Researchers Awarded Grant to Find Just the Right Classroom Environment for Learning

Table 3: Table of title edits made throughout the press release drafting process, with changes highlighted in red.

The two major title changes occurred in drafts 3 and 11. The title change in draft 3 was made in an effort to make the title catchier and more interesting to a potential reader. The change in draft 11 (the inclusion of the word "classroom") was to include the phrase "classroom environment," identified as a popular search term by digital marketing, in the title of the article to enhance the chances of the article appearing on a search engine.

Section 5.2.1.1.2: Digital Marketing Search Engine Edits

The comments made by the digital marketing colleague I found to be the most interesting aspect of the revision process. The colleague included aspects such as potential keywords, popular search query questions, and meta titles and descriptions that would all help boost the article's visibility on search engines. In addition to identifying these words and phrases, they also included the frequency that each word or phrase was searched each month to delineate which were most popular and would most likely boost visibility.

As the purpose of including these popular search engine terms in the article is to increase the likelihood a prospective student were to "stumble" upon the article, using Google, I looked up the various terms and questions that were identified to see if I was able to find the WPI Press release on a Google Search page. For this study, I limited my search to pages 1-10 of Google Results. As of February 10, 2020, out of the eight identified popular search terms and questions, I was able to find the press release while searching for one identified phrase and one question, for a 25% success rate:

- Classroom temperature: page 6
- How classroom temperature affects learning: page 5

By Googling these search terms, it shows how important digital marketing's role is in the press release drafting process. Without identifying these popular search queries, there is the chance that no one would find this press release on a search engine, which decreases the likelihood that reporters and prospective students would happen to come across the article, thus decreasing the chances of media attention and student attraction.

Section 5.3: Final Press Release

Prior to publishing it on the WPI website, Lisa completed the WPI Press Release Checklist. Lisa created a long and a short headline for the article. As previously mentioned, the long headline serves as the press release's main title while the short one is used for websites that do not have the character space for the long title. Lisa then chose an eye-catching quote from the press release as well as went back into the final press release and added in relevant hyperlinks. If the

reader is interested, these hyperlinks will allow them to delve further into some of the topics mentioned into the article with minimal effort.

Lisa also focused her attention on the information that would be uploaded to Drupal. For this press release, it is inputted into the system under the research umbrella term. It was then given tags such as *engineering*, *National Science Foundation* (where the grant for the project came from), and *seed funding* to further categorize the article's topics. It also includes tags such as the types of STEM areas it involves, the faculty that are a part of the research, and if it is being done at a WPI project center. In the case of the NSF tag, it gives credit to the agency that helped fund the research project in the hopes that they will continue to fund further research at WPI. The other tags included all fall under WPI-centric categories, meant to drive readers to look further into WPI programs and initiatives in the hopes of recruiting new students.

The final part of the checklist is including the various WPI website pages the article should be published on. For this press release, it was included on the home page, computer science page, architectural engineering page, research faculty pages, and the research page.

After completing this checklist, Lisa sent the final press release and checklist to the member of the marketing department who will support the press release. She also included photo captions as well as proposed Tweets in the email. Once Lisa sent this press release package, her involvement with the article ended.

Section 5.4: Media Attention from Forbes

While I was not able to see the post publication marketing process unfold for this article, shortly after Lisa published this press release, a *Forbes* contributor, Mark Travers, picked up the article and wrote his own news article, which he published to the *Forbes* website. I analyzed his article, entitled Too Hot, Too Cold? Scientists Search for the Optimal Temperature For Learning, to get a better understanding of how a media news article might differ from a WPI press release. These comparisons helped show if both a university press release and media press release follow similar best practices. Table 4 compares the similarities and differences between WPI press release and Traver's *Forbes* news article.

WPI Press Release	Forbes News Article	Comments
Title: Not Too Hot, Not Too Cold: WPI Researchers Awarded Grant to Find Just the Right Classroom Environment for Learning	**Title**: Too Hot, Too Cold? Scientists Search For The Optimal Temperature For Learning	The titles of the two articles are very similar, with the title of the Forbes article a copy/paraphrase of Lisa's article. This showed that Lisa's title was written like a reporter would write it, so Travers only had to do minimal editing to the title
"When we look at how student learning can be improved, a lot of researchers start from the perspective of	"When we look at how student learning can be improved, a lot of researchers start from the perspective of	The quote included in the Forbes article was taken directly from the WPI press release. The difference is that

pedagogy and teaching materials," Liu said. "As an engineer in building sciences, I know indoor environmental quality is a big factor that affects people's comfort and cognitive performance."	pedagogy and teaching materials," says Shichao Liu, a professor of architectural engineering at Worcester Polytechnic Institute. "As an engineer in building sciences, I know indoor environmental quality is a big factor that affects people's comfort and cognitive performance."	the WPI article introduces the faculty working on this research at the beginning of their press release, while Travers introduces them throughout the article and uses the beginning of his press release to "set the stage" for the information to come.
Grant: $299,991 from the NSF, mentioned in the first sentence of the article	**Grant**: $299,991 from the NSF, mentioned in the middle of the press release	Both articles mention the exact grant amount this research was awarded, but it was placed in different locations of the article. This highlights the emphasis that WPI places on grant money that is awarded to the university as it shows outside readers that WPI's research is funded by well-known agencies. This will not only attract further agency funding, but also attract prospective college students to WPI as it shows that the university receives funding for its research. As Travers' interests include psychology and learning environments, the grant that WPI received was, most likely, not as important of a focus as the actual research was.
To start, the researchers will use computer vision to film the faces of 24 undergraduate volunteers as they watch recorded lectures in different simulated settings—a lecture hall, a computer lab, and a virtual reality environment. Temperature, light, and ventilation will be varied, too.	First, Liu and his team plan to develop computer vision software to measure moment-by-moment changes in student engagement. "Understanding student engagement requires approaches to measure it," state Liu and his collaborators. "Our goal is to employ computer vision to detect students'	Lisa's article gives an overview of the first stage of the project and focuses on the inclusion of undergraduate volunteers in this research. Travers' called the researchers for additional quotes on their research.

	disengagement especially when caused by poor physical environment."	
Finally, the researchers will study how a second group of 24 students engage in recorded lectures after a change in air flow from a fan or a mild thermal stimulus from a wristband device designed to make the wearer feel warmer or cooler. A larger goal of the project is to inform the way buildings are designed and operated to account for how humans perform in them.	Finally, the researchers will explore whether experimentally-induced environmental changes can effectively combat lapses in student engagement. "Current indoor physical environments are designed to be static and uniform," state the researchers. "If students' satisfaction can be improved by creating a dynamic physical environment, we hypothesize that such an environment could reengage students directly or indirectly through enhanced satisfaction." Liu cites research showing that momentary changes in ambient light can have an "alerting" effect on people, similar to what happens when someone takes a sip of coffee.	The quote that Travers included in his article was not included in the WPI article. Lisa stresses that students will be volunteering as a part of this research to show student research involvement as well as touches on how the research can impact society. Showing that the research has student volunteers helps to recruit potential students as readers who are interested in this area of research now know that, at WPI, they could become involved in the study.
"In addition to the current focus on learning environments, insights from this study can also lead to development of new tools to investigate how people and buildings interact in more general terms," Van Dessel said. "Approaches developed as part of this project may be adapted to also study, for example, the impact of environmental factors, such as color or sound, and how they affect well-being."	"In addition to the current focus on learning environments, insights from this study can also lead to development of new tools to investigate how people and buildings interact in more general terms," says Van Dessel. "Approaches developed as part of this project may be adapted to also study, for example, the impact of environmental factors, such as color or sound, and how they affect well-being."	This quote was originally included in Lisa's article, which Travers also included in his article directly.
The research builds on a $10,000 seed grant awarded	N/A	Lisa mentions the seed grant that this research stemmed from, which is not mentioned

in 2018 by WPI's Office of the Dean of Engineering.		in the Forbes article. Mentioning the seed grant shows that WPI does not only get funding from outside agencies, but departments also work to fund their own programs. This again helps recruit prospective students by showing WPI has the money to invest in research. Mentioning a seed fund most likely wasn't important to Travers since his readers want to know more about the research being done, rather than the money behind it. Travers' interests lie in psychology and human potential and learning, and he promotes his media articles on his social media. Those that follow him likely have similar interests, so they are not as focused on grant money.
"I am delighted to see that the seed grant funding of the collaboration between Shichao Liu, Jake Whitehill, and Steven Van Dessel has been partly instrumental in enabling their successful application for this NSF Award," said Winston Soboyejo, WPI senior vice president and provost. "I look forward to their continued success, as we strive to develop WPI's efforts in the area of the Built Environment."	N/A	Lisa also included a quote from Winston Soboyejo, the Vice Provost of Research at WPI, to address how the research is supporting WPI's Built Environment initiative. Including this quote shows that even the executives at WPI are involved in research being done on-campus and that this research will be affecting the entire WPI community. This not only shows internal community building at WPI, but shows prospective faculty members that the entire WPI community cares about various research being done on campus, showing that if they would want to conduct

		research at WPI, they could engage in cross-departmental, truly collaborative research. WPI's initiatives are not something of as much importance to Travers, so including this in his article was not necessary.

Table 4: Comparison of the WPI press release to the Forbes news article.

As seen in Table 4, Travers article is a combination of direct quotes and paraphrasing of the WPI press release combined with some of his own research and interviews. As of April 23, 2020, it has over 600 views, which helps the research being done at WPI to spread to a wider audience.

In addition to analyzing Travers' article, I was able to email him a couple questions about his press release as well as his views on writing press releases to get further insight into the process.

For this story in particular, Travers heard about the research being done at WPI from his editor. Travers interests lie within science and psychology, so writing a press release about optimal classroom environments was already of interest to him. As a freelance news contributor for multiple media outlets, Travers receives information about many different topics he could write about, so he has to be picky about which he chooses to write about. His general rule is that he "writes about what [he] finds interesting since ... if [he] finds it interesting, [his] readers will too" (Travers, personal communication).

Aside from some article content, the two press releases were extremely similar, proving that both WPI content writers and media reporters follow the same press release best practices.

Chapter 6: Mock Press Release of Biochemistry MQP

After researching press release best practices and gaining first-hand knowledge about the press release process at WPI, I wrote a mock press release about the biochemistry portion of my joint MQP, which can be found in Section 6.1. I wanted to figure out if, after going through this process, the knowledge I gained about press releases would allow me to write one myself. Would I learn anything from writing one? Would there be other aspects about the genre I would realize after practicing? After writing this first draft, I sent it to Lisa Eckelbecker and my advisor, Professor Madan, for edits. While an actual press release would go through many more editing steps, opening my mock press release for comments gave a sense of the editing process. The draft I wrote following these comments can be found in Appendix C. Between the two drafts, the areas that changed the most were the title, sub-title, and a portion of the body, which is highlighted in yellow in the initial draft. These sections were too long and scientific for a press release, so revising them made them more interesting and understandable to a media reporter or general reader. In addition to these sections, edits were made to some of the vocabulary in the draft. A special focus was placed on eliminating the word "model", as the term is ambiguous and could be misinterpreted by the reader. Focusing especially on these edits, I reflected on the press release writing process as a whole, which can be found in Section 6.2. In addition, I considered the information I had gathered from the WPI marketing team, my case studies, as well as research into opinions of current media writers to incorporate what I learned in my reflection.

Section 6.1: Initial Mock Press Release Draft of Biochemistry MQP

WPI Student Researchers Create Preliminary Evolutionary Model to Combat Greenhouses Gases with Bacteria

Two WPI MQP students created an evolutionary model that could evolve E. coli bacteria to depend on greenhouses gases as a food source to help reduce methane emissions.

March 30, 2020

BY: KATHERINE VASCONCELOS

Two senior Worcester Polytechnic Institute (WPI) students genetically engineered an evolutionary model that, with further research, could take advantage of mutations in bacteria that will evolve them to use greenhouse gases as food.

Stemming from research conducted by Dr. David Liu on evolutionary models of viruses, James Andon and Katherine Vasconcelos have been working with Professor Destin Heilman, teaching professor of chemistry and biochemistry, to force the bacteria, *E.coli*, to evolve through genetic engineering using a technique called directed evolution. Liu's model, which uses viruses, can be difficult to replicate due to its complexity, so they sought to create a simpler model that could be performed within academic labs with more limited resources.

"There is a need for a simple, rapid evolution system that can be widely disseminated. We are on the cusp of a designer enzyme revolution if only we can push past one of two barriers; inadequate structure/function prediction or rapid selective evolution. This research has the

potential to surmount the latter and our strategy of placing simplification of the technique at the forefront is key to accessibility," says Heilman.

To start to design their preliminary model, the group created a bacteria system where *E. coli* would only survive if it could evolve to make a protein that it lacks. In order to grow, *E. coli* need to be able to produce twenty amino acids, which are molecules that encode for the proteins that are the building block of life. Andon and Vasconcelos decided to use *E. coli* bacteria that lacked the ability to produce methionine, one of these twenty amino acids. Without this ability, *E. coli* would not be able to grow. By designing a way to introduce a way for these *E. coli* cells to evolve to again produce methionine, their ability to grow would be restored.

Essentially, Andon and Vasconcelos are trying to recreate evolution that happens outside in nature, but on their terms. When organisms evolve naturally, it is so that they can better suit their environment to survive. For example, think about giraffes, which have changed to better fit their environment. They evolved to have long necks since, as trees got taller, giraffes with longer necks had better access to more food so that today, the only giraffes that survived are ones with long necks.

"We are attempting to do the same thing in a test tube, but instead of giraffes confronting the problem of reaching food in high places, we're forcing bacteria to confront the problem of not having access to something they need, like methionine. If we can link the regaining of methionine to a certain gene we're interested in, then we can trick the bacteria into evolving this gene just like the giraffe's evolved longer necks," says Andon.

Next was genetically engineering a system that could restore methionine production to these *E. coli* cells so they could survive. Using Liu's research, they decided to use the protein methanol dehydrogenase, or Mdh2, to link methionine and survivability. If the *E. coli* cell can produce Mdh2, then Mdh2 will be able to convert methanol into a molecule that allows for *E. coli* to produce methionine. Once this link between methionine and Mdh2 was established, they had to figure out a way to make this process more effective.

They identified another protein, called Error Prone DNA Polymerase I, that could do just that. This protein would randomly mutate Mdh2 and introduce a mutation that would increase the rate of this process. This mutation allows for evolution to take over: cells that have it will be able to survive and make methionine, while those that do not will die.

Next came testing the model in a test tube. It consists of three sets of DNA. The first contains the Error Prone DNA Polymerase I, which will mutate and evolve the second set, which contains Mdh2, the molecule that converts methanol. The third contains the gene needed for methionine production to keep the bacteria alive, which will only appear if evolution occurs.

"While our model does not directly convert methane to a food source, since we use methanol, we hope that if we can prove that this model is functional, we can then take it a step further and introduce methane. Methanol can be produced from methane, which suggests that further improvements could eventually lead to evolving *E. coli* to depend on methane as a food source," says Katherine.

Currently, the group is testing if they can successfully produce mutations that will evolve the bacteria so it can survive. Their next step is to continue carrying experiments in *E. coli* to test if they are able to evolve the *E. coli* cells so they are able to survive.

About Worcester Polytechnic Institute

Worcester Polytechnic Institute, a purpose-driven community of educators and researchers, has been the global leader in project-based learning for 50 years. An impact maker for higher education and the world, WPI prepares confident, competent problem solvers with a project-based curriculum that immerses students in authentic, real-world experiences.

Section 6.2: Reflection on Writing a Press Release

As this was a genre I was unfamiliar with before I completed this MQP, I originally thought I would find writing a press release more difficult, but the writing process surprised me. I found that, structurally, it is relatively easy to follow a press release template. However, the substance of a press release is much more difficult to write.

What Needed Improvement

I faced the most challenges when writing the content of this mock press release. When writing the first draft, I had originally found the title easier to write than I imagined. After sending the draft for edits, it became apparent that it was much more difficult to write an effective title. Lisa suggested some changes, such as to eliminate the word "model" since, for a general audience, there could be a discrepancy in the understanding of this word. As "model" is a general term and press releases aim to not leave room for misinterpretations, Lisa suggested revising not only the title, but the body of the press release, to remove this word. The title of the press release in draft one was, "WPI Student Researchers Create Preliminary Evolutionary Model to Combat Greenhouse Gases with Bacteria" while the title in draft two is, "WPI Student Researchers Engineer Bacteria to Combat Greenhouse Gases." Not only does this eliminate the word "model", but the second revision is shorter, thus placing more emphasis on the idea of eliminating greenhouse gases.

As I revised the title to remove the word "model", I made further changes to switch verb emphasis as well as shorten the title. In the first version, the word "create" serves as the main action verb, while in the second title, "engineer" is the focus. "Engineer" alludes to the design process of the MQP, which helped eliminate the word "model" through eliminating the phrase "create preliminary evolutionary model". In addition, emphasizing that we engineered bacteria made the project less ambiguous as the title explicitly states the MQP's goal. Shortening the title and making it more impactful would help the article grab a media reporter's attention more effectively. They may read hundreds of press releases a week, so it is important to convey an idea succinctly and in minimal words.

Changes to the title lead to a revision of the subtitle, another aspect of the press release I struggled with. The original subtitle read "Two WPI MQP students created an evolutionary model that could evolve *E. coli* bacteria to depend on greenhouse gases as a good source to help reduce methane emissions." Not only is this long, but it repeated most of the information in the original title. As part of his press release rules, Wayne states that it is not only important to

quickly get to the point, but to also avoid repeating the header. Lisa also suggested revising the sub-header by considering what new information I could introduce. Repeating information is boring for any type of reader. I revised the sub-header in the second draft to "Two WPI MQP students attempt to evolve bacteria that would consume methane emissions as a food source." When compared to the second title, this sub-header now introduces the ideas of evolution and using methane as a bacterial food source. Furthermore, it is shorter than the original sub-title, thus giving a media reporter less to read.

Overall, I found that I struggled the most with taking a complex, science-heavy topic and putting it into terms that a general audience reader could understand. The portion of the press release in the first draft, highlighted in yellow and also presented below, was the section of the body that I found most difficult to write.

"Next was genetically engineering a system that could restore methionine production to these *E. coli* cells so they could survive. Using Liu's research, they decided to use the protein methanol dehydrogenase, or Mdh2, to link methionine and survivability. If the *E. coli* cell can produce Mdh2, then Mdh2 will be able to convert methanol into a molecule that allows for *E. coli* to produce methionine. Once this link between methionine and Mdh2 was established, they had to figure out a way to make this process more effective.

They identified another protein, called Error Prone DNA Polymerase I, that could do just that. This protein would randomly mutate Mdh2 and introduce a mutation that would increase the rate of this process. This mutation allows for evolution to take over: cells that have it will be able to survive and make methionine, while those that do not will die.

Next came testing the model in a test tube. It consists of three sets of DNA. The first contains the Error Prone DNA Polymerase I, which will mutate and evolve the second set, which contains Mdh2, the molecule that converts methanol. The third contains the gene needed for methionine production to keep the bacteria alive, which will only appear if evolution occurs."

In this draft, it is easy to tell that the language is extremely science heavy, includes specific, unfamiliar terms, and dives too deep into the process for the average reader. Lisa made a very revealing comment about this section that truly speaks to the press release process as a whole: a press release is an invitation to outside readers that invites them to ask questions. It is unnecessary to tell the entire story in the press release as we want readers to ask questions to lure them into the story. Explaining the entire research story in the press release undermines its goal of garnering public and media attention. We want readers to ask questions, to want to delve into the topic. If they are interested, they will ask for more detail. As it is much easier to explain a detailed process in person or over the phone than over writing, having a long body risks losing readers interest.

In the second draft, I distilled these paragraphs into a single paragraph (highlighted in blue in Appendix C and presented below).

"Next was genetically engineering a system that could restore methionine production to these *E. coli* cells so they could survive. The team decided to create a system that could randomly mutate *E. coli* DNA to give it the ability to make methionine again. Then, mutations will allow for

evolution to take over: cells that have it will be able to survive and make methionine, while those that do not will die."

Not only does this revision shorten the section, but I explain the system from a broader approach, eliminating specific project terms by focusing more on the concept of mutation, which is more widely understood by a general reader. By shortening this section, the reader can focus more on the quotes and what the project aims to do: combat greenhouse gases.

What Went Well

Although I struggled with writing parts of the content of my press release, I was surprised to find how natural some parts of writing this mock press release about the biochemistry part of my MQP felt. Places where I wanted to add quotes from my advisor as well as partner felt natural since, as I wrote, I felt compelled to include notes of where I wanted to add quotes and what I hoped they would address. The structure of Lisa's press release, as well as others I read, helped me decide where quotes would be best. I wanted to include them in areas that I felt would explain the purpose behind the research, its implications, and future directions. After adding in these notes, I compared the location of my quotes and what they addressed to Lisa's press release. As I was able to model the location and substance of my quotes after other press releases, I realized that they are an easy form to structurally copy. Press releases need quotes, not only to further the article's substance, but also for media reporters, as seen in Travers' *Forbes* article. Reporters can take these quotes directly from the press release and include them in their own article.

Overall, I found that press releases are easy to write structurally as they all have the same format: a short, catchy title, a sub-title to further explain and market the article's body, quotes that address important and real world applications, and a body that explains the topic just enough to invite further inquiries. Press releases are not like academic essays, which are each unique and have more structural freedom. They have a predictable format that make it easily recognizable, thus making it easier for reporters to quickly write articles based on a press release. However, while a press release is structurally rigid, I found its content complex and more difficult to write.

The title, sub-title, and parts of the body underwent major revisions between drafts. As press releases are not academic essays, the goal is not to tell the entire story. It is to capture a reader's attention quickly and, by the end, leave them wanting to know more. My original title was too ambiguous as it was too wordy and used words like "model" that could be misinterpreted. It is important that a press release does not leave room for misinterpretation as the reader should leave wanting to know more, not needing concepts further explained. My sub-title also needed revisions as it not only was too long but repeated what the original title said. It is important that the sub-title presents additional information to the title and encourages the reader to keep reading, rather than them becoming bored with the topic. Finally, translating a scientific topic into simpler terms was extremely difficult. Deciding which words the reader would understand made explaining the topic difficult, as seen in the first draft. The revisions made in the second draft shortened the body and left the reader with an invitation to ask further questions about the system, rather than trying to present the entire research project in a wordy and confusing manner.

Writing this mock press release truly showed how complex of a genre press releases are, even though they may look simple at first glance. The content and words are purposefully chosen to leave the reader educated about the research while leaving them wanting to know more.

Chapter 7: Closing Thoughts

After understanding the lifecycle of a press release at WPI, seeing this process in action, and attempting to write my own press release, I composed the following ideas and concluding thoughts for the marketing department to consider as I reflected on this project.

Since one of WPI's university-wide goals is to recruit more undergraduate and, especially, graduate students, one function of a press release is to entice students. However, as I was reading some of WPI's press releases from the perspective of not only a current student, but also someone who toured and applied to colleges just four years ago, I felt that there was a lack of focus on student research. While, where applicable, the press releases highlighted that research has student participants or will be looking for students to volunteer, it does not necessarily focus on what aspects of a research project they focus on. Participating in on-campus research was something I knew I wanted when I was a high school senior, but from these press releases, I would not have felt that WPI fit this want. Currently, explaining student research on-campus mostly falls to the admissions department.

As a tour guide, I always felt that parents were most impressed with WPI when I spoke to them about previous IQPs and MQPs. Particularly while presenting MQPs, students can see how they can integrate their passions into their area of study. The ability to design and execute their own project not only excites prospective students but is one of WPI's biggest strengths. However, aside from on-campus admissions events, prospective undergraduate and graduate students have limited options to read about current student research, which detracts from recruiting efforts. Since press releases have a recruitment goal, the marketing department should try to further student presence in press releases.

One option could be to incorporate student's perspectives into press releases about faculty research. While marketing does have some publications that includes student research, such as the quarterly journal and social media posts, if press releases aim to recruit new undergraduate and graduate students from other universities, including quotes and snips from them could add an additional dimension. Adding additional student-focused content would help readers to better understand what they could expect to work on as well as what skills they might learn.

Alongside including more student comments in press releases, could marketing write and publish press releases solely focused on student research? This could give prospective students a better view of what student research at WPI is like. However, press releases may not be the proper format for these stories as a student press release could undermine the goal of attracting media attention. Student research often carries between years, with the researchers changing annually, or is not completed (for example, in the instance of COVID-19 halting projects). It is very difficult to complete research projects of the same scale as faculty members in under a year, so these projects may not be of interest to the media as they do not have the same implications as faculty research. In addition, they do not all receive funding from grant institutions, so these press releases would also undermine the goal of garnering more funding for the university.

Nonetheless, some student research could be well-displayed in a press release format, possibly as a call out box or a brief "student researcher" spotlight within a press release. Some student

research being done is a part of a faculty's project, so spotlighting a student's role within the lab and the work they have done so far may give this more personal element to prospective students. This would give the student's work credibility and recognition, as it shows that WPI views all research, from faculty to students, as serious, important, and worthy of being published. WPI values students researchers, so highlighting them would only show prospective students what they can accomplish on campus. In addition, this could also appeal towards parents as student research contributes towards WPI's return on investment. Seeing what current students do on campus would show parents that their child would not just be sitting in a lecture hall; they would be taking a hands-on approach to their learning while taking advantage of the numerous resources WPI has to offer.

As seen through interviews, case studies, and personal reflections, the genre of press releases truly goes beyond a written document. Not only does it serve as a tool for marketing to promote faculty research but is also a marketing ploy to attract media attention to institutions. Each word written in a press release serves a purpose as the media reporters who read it may quickly decide if a story is worth pursuing. The title needs to catch their attention, the sub-title needs to give a quick view into why the research is important, and the body provides a source of information for media reporters to grab what they like and fashion it into their own news article. Behind the written document, marketing research is done to increase the likelihood that it will appear to the general public through search engines, while funding agencies are promoted to encourage further funding to the university. As whole, the press release genre and its complexities were extremely surprising to me, and it is truly incredible how far a short document travels.

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Appendix A: Key Messages Template Framework

Title / theme here

Messages to be delivered in future media interviews.

Key Message #1 (Problem/Solution)
No more than 30 words.

Support Points

- X
- X
- X

Proposed quote:

Key Message #2 (Fact/Result)
No more than 30 words.

Support Points

- X
- X
- X

Proposed quote:

Key Message #3 (Benefits)
No more than 30 words.

Support Points

- X
- X
- X

Proposed quote:

Appendix B: Final Press Release Checklist

The following is a filled out final press release checklist for the case study article. Highlighted text are "answers" to the checklist.

Press Release Checklist

- **Long headline**: Not Too Hot, Not Too Cold: WPI Researchers Awarded Grant to Find Just the Right Classroom Environment for Learning

- **Short headline** (no more than 60 characters, including spaces): WPI Awarded Grant to Study Best Environment for Learning
- Story content, which also includes:
    - Pull quotes (recommended in most cases to help break up long blocks of copy)

"Environmental quality is a big factor that affects people's comfort and cognitive performance." - Shichao Liu, Assistant Professor of Architectural Engineering at WPI

    - Subheads when appropriate (again, to help break up long blocks of copy) No
    - Inset images (with captions) Please use file photos of Liu, Whitehill, Van Dessel
    - Hyperlinks to relevant content on wpi.edu (ex. department, office, program, faculty profile) – these should be embedded within the release Done
- Other images for a media gallery? Is there a video? No

Related Content:

    - Is the story about research? Add a box with sign up for Research Newsletter

Information Needed For Posting in Drupal

- **Publication:** can select multiple options: Press Release, Research
- **Tags**
    - **1. Story Tracking:** Select one of these: **Research**
    - **2. News Campaign** (only used for high level campaigns): ex. Malaria, Heart on Spinach, Seaport No
    - **3. Topics/Tags:** Engineering, Research, National Science Foundation, Computer Science, Seed Funding
    - **4. Department/Office** the story is associated with: School of Engineering, Architectural Engineering program, Department of Computer Science
    - **5. Faculty or Staff member(s) featured in the story:**
        - Shichao Liu, assistant professor of architectural engineering
        - Steven Van Dessel, associate professor of architectural engineering
        - Jacob Whitehill, assistant professor computer science
    - **6. On-campus location (if applicable)** None
    - **7. Project Center related to story (if applicable)** None
    - **8. Patent: Does the story involve an existing patent?** No
- **Post Story to Website:**
        - Home page
        - Computer Science page
        - Architectural Engineering page

- Faculty page
- Research page

Appendix C: Second Draft of Mock Press Release

WPI Student Researchers Engineer Bacteria to Combat Greenhouse Gases

Two WPI MQP students attempt to evolve bacteria that would consume methane emissions as a food source.

March 30, 2020

BY: KATHERINE VASCONCELOS

Two senior Worcester Polytechnic Institute (WPI) students genetically engineered *E. coli* bacteria that could, with further research, be developed to use greenhouse gases as food.

James Andon, from Norfolk, MA, and Katherine Vasconcelos, from Lakeville, MA, both WPI seniors majoring in biochemistry, have been using a technique called directed evolution to force bacteria to evolve. As a part of their MQP, the two students worked with Destin Heilman, teaching professor of chemistry and biochemistry. Their worked stemmed from research done at Harvard University on evolutionary models of viruses. Andon and Vasconcelos were inspired to create a simplified version of this research as virus models are complex, so they hoped to create a model that could be performed in academic labs that have more limited resources.

"There is a need for a simple, rapid evolution system that can be widely disseminated," said Heilman. "We are on the cusp of a designer enzyme revolution if only we can push past one of two barriers; inadequate structure/function prediction or rapid selective evolution. This research has the potential to surmount the latter and our strategy of placing simplification of the technique at the forefront is key to accessibility."

To design their preliminary model, the group began by creating a bacteria system where *E. coli* would only survive if it could evolve to make a protein that it lacks. In order to grow, *E. coli* need to be able to produce twenty amino acids, which are molecules that encode for the proteins that are the building block of life. Andon and Vasconcelos decided to use *E. coli* bacteria that lacked the ability to produce methionine, one of these twenty amino acids. Without this ability, *E. coli* would not be able to grow. By a designing a method for these *E. coli* cells to evolve to again produce methionine, their ability to grow would be restored.

Essentially, Andon and Vasconcelos are trying to recreate evolution that happens outside in nature, but on their terms. When organisms evolve naturally, it is so that they can better suit their environment to survive. For example, think about giraffes, which have changed to better fit their environment. They evolved to have long necks since, as trees got taller, giraffes with longer necks had better access to more food so that today, the only giraffes that survived are ones with long necks.

"We are attempting to do the same thing in a test tube, but instead of giraffes confronting the problem of reaching food in high places, we're forcing bacteria to confront the problem of not having access to something they need, like methionine," says Andon. "If we can link the

regaining of methionine to a certain gene we're interested in, then we can trick the bacteria into evolving this gene just like the giraffe's evolved longer necks."

Next was genetically engineering a system that could restore methionine production to these *E. coli* cells so they could survive. The team decided to create a system that could randomly mutate *E. coli* DNA to give it the ability to make methionine again. Then, mutations will allow for evolution to take over: cells that have it will be able to survive and make methionine, while those that do not will die.

"While our model does not directly convert methane to a food source, as we are testing if we can force *E. coli* to evolve, we hope that further improvements to the system could eventually lead to evolving *E. coli* to depend on methane as a food source," says Vasconcelos. "This model suggests a first step in this process. By showing we can link bacteria mutations to survivability, we hope to translate this by mutating bacteria into needing greenhouse gases in order to survive to help combat climate change.

Currently, the group is testing if they can successfully produce mutations in *E. coli* bacteria. Their next step is to continue carrying experiments in *E. coli* to test if they are able to evolve the *E. coli* cells so they are able to survive.

About Worcester Polytechnic Institute

Worcester Polytechnic Institute, a purpose-driven community of educators and researchers, has been the global leader in project-based learning for 50 years. An impact maker for higher education and the world, WPI prepares confident, competent problem solvers with a project-based curriculum that immerses students in authentic, real-world experiences.