

A Hands-on Project to Promote Student Engagement and Motivation in High School

Metal Shop

by

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Bachelor of Education, University of British Columbia, 2000

A Project Submitted in Partial Fulfillment of the Requirements for the Degree of

MASTERS OF EDUCATION

in the Department of Curriculum and Instruction

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## **Abstract**

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Student motivation and engagement and how they can be used to create hands-on projects in the high school metalshop were examined. Project selection is critical to the success of elective courses; not only do the projects need to satisfy the learning outcomes of the course, but they must also motivate and engage students. Current literature about student motivation, engagement and mindset, as well as personal observation of students in my own classroom were used to provide a foundation for the selection and development of a hands-on project for a high school metalworking class. A 2 x 72 inch variable speed belt grinder was chosen as a project for senior metalworking students. This project was carefully designed to make it accessible for students and a set of detailed instructions known as a cookbook was created to assist in maintaining student motivation while building this challenging hands-on project.

## Dedication

I would like to dedicate this project to three men who in one way or another helped shape the person I am today. My father showed me that no matter how big a challenge or task I am faced with, perseverance and hard work can see it through. Anything is possible. My uncle Kenneth Payne taught me a phrase that has stuck with me and which I often share with my students: “A job worth doing is a job worth doing well.” Thank you uncle Ken, you could not be more correct. And finally, I would like to dedicate this paper to my grandfather Charles Coddling, whose love of crafting things with his hands was somehow passed on to me; for that I am forever grateful.

## **Acknowledgments**

I would like to thank my partner Kate Peatfield for her love, support, and editing interventions over the past two years. I couldn't have done it without you! Thank you to my brother Robert who is always there for me, helping me whenever he can, whether as a sounding board for ideas for this masters project, or helping me to clear land on our new property in any spare moments of the past two years. Finally a warm thank you to all my family, friends, and colleagues that have helped and encouraged me along the way.

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## **Chapter One: Introduction**

### **Who am I?**

I am a guy who likes to build things. For some reason I have always been interested in making and fixing things. Today it seems that everything can either be bought or you can hire someone else to fix or build whatever you want. But that is not my way. My maternal Grandfather was a master cabinetmaker and although I spent very little time with him, my Mother insists that some of my Grandfather's skills and ability to make things had somehow been passed on to me. My father was a heavy duty mechanic and amateur boat builder. On his own, he built a 48 foot sailboat. He constructed the entire thing with his own hands, hull, interior, electrical, plumbing, and rigging. I do not think there was anything my Dad could not do.

At times I wonder why I insist on doing the things that I do. I have owned and operated vehicles (not brand new ones by any means) for the past 26 years, and have never had to pay a mechanic to repair or maintain any of them as; I do my own vehicle maintenance and repair. I have restored two Toyota Land Cruisers; one was a complete frame- off restoration with significant custom features. I have rebuilt several engines and performed a complete tear down and re- assembly of a Chrysler 47RE automatic transmission. I even machined all the special tools necessary to do the rebuild.

I enjoy fishing and hunting and have made custom fishing rods, tied my own flies, and cast lead weights for river and ocean fishing. A fisherman needs a boat, so when I moved to Vancouver Island I found an old boat and completely rebuilt it. I fibre- glassed new stringers, transom, bulkhead and sole. I replaced the fuel tanks and plumbing, completely re -wired the electrical system, and rebuilt the engine and outdrive. When hunting, I shoot my own hand

loaded ammunition rather than buy off –the- shelf factory ammunition. There is a great satisfaction in being able to create, with my own hands, things that I and others can enjoy.

My twin brother and I bought a 1940's bungalow in East Vancouver in 2000. The house was in poor condition and was in need of significant renovation. My brother is a Chartered Accountant and I am a Tool and Die maker and shop teacher, neither one of us had significant experience in the building trades. It took us three years, but that house was lifted off its old foundation, dropped back down onto a new foundation and completely rebuilt into a new house. We poured the concrete, framed a new main floor and 10 foot addition, and re-structured the second floor including re trussing the roof. I pulled a homeowner permit and wired the entire house, most of the plumbing, interior finish carpentry, exterior siding and trim, and even did all the painting.

### **Why do I do what I do?**

I sometimes wonder why I do what I do; I would have more free time and not have to work so hard if I would just pay people to do many of the things that I feel compelled to do myself. My wife and I just bought 2-1/2 acres of treed land, where we plan to build a house and home for ourselves. Where most would hire a contractor to clear the land and build the house, I have bought an excavator to knock over trees and prepare the site for building. I look forward to breaks in the school year when I hope to begin the hard labour that comes with setting the forms and pouring the concrete for the foundation of the house soon to follow. Many would loathe the thought of starting a project that will undoubtedly include many hours of hard labour, but I look forward to it, knowing that I will be satisfied with the end result and enjoy the fruits of my labour. I do not consider hard work to be a bad thing.

Some would suggest that saving money is the motivating factor in doing what I do. Undeniably there is some validity to this, but many of the things that I am motivated to do are not about saving money. Doing my taxes is one such example. I know that I will get a sizeable return when the forms are completed, but it is a task that I struggle to complete on time. If I were to calculate a per hour wage for completing my tax forms, it may well be the highest paying job I have ever had!

Like many people, when I become engaged with a project, it is easier and more enjoyable to stay focussed and on task. We all have tasks we know we should do, but have a hard time doing. As I reflect on my own motivation, I see that one of the things that keeps me motivated and engaged in projects is working on something that result in a tangible product. Some people become disillusioned with projects that take considerable time to complete, but this is not an issue for me. Even a project as large in scale as a house build satisfies the need to see tangible results on a frequent basis. Strong motivation makes even the most daunting tasks achievable; likewise, a lack of motivation makes even minor tasks an unpleasant or unfulfilling experience. As a teacher, I want my students to be motivated to do the tasks that I ask them to do.

### **Shop class and what I am interested in studying**

Shop class, or what is currently known as Technology Education has in my own experience seen a general decline in student enrollment and popularity in many schools and districts in British Columbia. There are many factors that have been suggested as contributors: changing public perceptions of the value of trade or hands-on careers; lack of funding to maintain and upgrade facilities; teacher popularity; and project choices. I maintain such a positive and strong perception of the value and importance of shop class that I feel that there needs to be positive steps taken to investigate and reverse this trend, and return shop class to the

place of importance it needs to be in high school education. Currently there is a widely publicized concern for the lack of skilled trades people in British Columbia, and it is projected to become significantly worse in the next ten years. (Clancy, 2014). If we wish to engage students in future careers as trades people, I feel that one of the best ways to interest our youth in trades careers is with positive experiences - in our high school shop classes.

Shop classes are considered to be an applied skill. Applied skills course credits are needed to comply with B.C. graduation requirements. But, students can receive applied skills credits through a variety of course offerings that are not in the shop area. Subscription to shop classes is for the most part by student choice. If students do not want to take shop classes, they will not sign up. What are the important factors that influence a student when it comes to selecting elective courses? Identifying factors through the literature, that influence student motivation will be helpful to me in designing course work and projects that will be both engaging for students, and provide students with the necessary motivation to want to engage in this type of work. Having students engaged in classroom activities is always a goal for classroom teachers, while choosing projects that encourage student engagement and result in motivated students is a desirable outcome. For my M Ed project I will define and study student engagement, and factors that influence student motivation through the existing literature. With this information, I will then design and document the creation of a number of shop projects to maximize student motivation and engagement for my own teaching and a resource for other shop teachers.

## **Chapter Two: Literature Review**

I really enjoy teaching shop class and feel that students benefit from taking shop classes. Some students choose shop classes as a step in reaching their future career path, for other students it is just one of the many elective courses that they can choose from. It behooves the shop teacher to ensure the curriculum they present is as motivating and engaging as possible to encourage the students to take these classes. In my literature review I intend to review current research on: student motivation, mindset, and engagement. I intend to use this information to create a project in my shop class to better motivate and engage my students.

### **Challenging times**

Raising the importance of shop class is a complicated and challenging goal. Shop classes, or Technology Education as it is frequently called, is in a dilapidated state of being in many schools and districts across British Columbia. Student subscription to shop classes has, in recent years, declined. As a result, many shop programs have seen a reduction in popularity or they have disappeared altogether. A reduction in sign-up for shop classes has in many cases made the re-purposing of operationally expensive shop facilities a convenient decision for school administrators. I have taught in three high school shops in my fifteen year teaching career, and the shop facilities and equipment in all three showed the ill effects of underfunding and neglect. One of the common complaints of Technology Education teachers in British Columbia is that of underfunding for both materials and equipment. The suggestion being that it is difficult to engage student's interest with equipment and tooling that has remained essentially unchanged in the past fifty years. At parent teacher interviews the parents often remark that the shops look just like it did when they were in school. Fifteen years ago, prior to entering the teaching profession, I apprenticed in a Tool and Die shop in North Vancouver. Even fifteen years ago, the technology

and equipment we used in that shop far exceed the ancient equipment and technology I have available in my shop today. In today's technology driven climate, old or outdated technology could certainly be one of the factors to explain the reduced enrollment and lack of engagement for some of our students. In the near future, there is not likely to be a significant infusion of capital to update the aging infrastructure of our shops, but we can do our utmost to understand and address the issues of student motivation and engagement and how what we do as shop teachers affects the students whom we teach.

### **Motivation**

When I am motivated to complete a task or learn something new, the task or learning goal is so much easier or enjoyable. When the motivation is not present, it is so much more difficult staying on task and being productive. Having taught in a variety of shops and many different subject areas, it is very clear that having motivated students makes one's job as educator and their lives as students more enjoyable and productive. Motivation (2014) as defined in the Merriam – Webster online dictionary:

- the act or process of giving someone a reason for doing something : the act or process of motivating someone
- the condition of being eager to act or work : the condition of being motivated
- a force or influence that causes someone to do something

While the above definition seems simple, my review of the literature has shown the factors that influence student motivation in students is more complex. A project or task that motivates one student to engage and perform to the best of their abilities may not motivate others to do the same (Thijs & Verkuyten, 2010). Throughout the next sections of this chapter, I will

examine various theories from the literature that help to explain and build an understanding of student motivation and engagement.

**Intrinsic and Extrinsic motivation.** Intrinsic and extrinsic motivation has been studied by many researchers as important factors influencing student motivation. Intrinsic motivation can be described as performing a task or engaging in an activity for the sake of the task itself; the activity may be fun, or challenging, or it may satisfy the curiosity of the learner (Ryan & Deci, 2000; Williams & Williams, 2011). Tasks that are intrinsically motivating can be described as a task one would do without need for external reward. As educators, it would be desirable if the tasks or activities we asked of our students were intrinsically motivating, but unfortunately this is not always the case.

Extrinsic motivation exists when the learner is performing a task or activity for other reasons, such as: seeking the approval of others, seeking rewards, or to avoid extra work or punishment (Ryan & Deci, 2000). It is recognized by many researchers that with school-aged students, intrinsic motivation decreases with the age of the student (Ryan and Deci, 2000; McGeown et al., 2013; Meece, Anderman & Anderman, 2006).

The journal article “Intrinsic and Extrinsic Motivations: Classic Definitions and New Directions” by Ryan and Deci (2000) describes and details the differences between intrinsic and extrinsic motivation, and how they relate to one another. One of the challenges in studying motivation is that it is a constantly changing and situationally dependent construct. Ryan and Deci (2000) suggest; “People have not only different amounts, but also different kinds of motivation. That is they vary not only in level of motivation (i.e. How much motivation), but also in the orientation of that motivation (i.e. what type of motivation)” (p. 54). An example from teaching Metalwork nine for many years is the popular balance man project. I have had

highly motivated students who are intrinsically motivated because it is fun to create artifacts in the shop, and I have had students (fewer mind you) who are extrinsically motivated by the desire to receive an A mark, make the Principals' honor roll, and make their parents happy. Of course in the very same class, there are undoubtedly a few students that are not engaged with the project at all.

**Extrinsic Motivation.** It would be wonderful if all the activities and tasks we had for students were intrinsically motivating, but this is not a reality. Tasks that are intrinsically motivating for one student may not be for others. Saeed and Zyngier (2012) suggest that extrinsic motivation needs to be understood as “many of the classroom activities that a teacher wants students to do are not necessarily in themselves interesting or enjoyable”(p. 254), Ryan and Deci (2000) describe in detail the range that extrinsic motivation may occur. This ranges from amotivation at one extreme to a more autonomous form of motivation at the other. An example of a student that depicts amotive behavior is one who complies with a request to perform a task in order to prevent them from receiving a detention; the student merely complies with the request to prevent a negative result. This can result in the student feeling a lack of control and choice in the matter, which results in a reduction of autonomy which may contribute to a decrease in intrinsic motivation. A student may engage in the arguably mundane task of completing a drilling and tapping exercise knowing that their desired future career as Millwright will require this very skill set; in this case, the student has a sense of autonomy in the matter which can create motivation that is closer to intrinsic.

**Intrinsic Motivation.** Intrinsic motivation is typically described as an activity where the “reward was in the activity itself” (Ryan & Deci, 2000, p. 57). Intrinsic motivation is generally considered to be a better motivating factor in academic studies than extrinsic motivation;

according to Saeed and Zyngier (2012), “Numerous research studies have shown that intrinsically motivated students have higher achievement levels, lower levels of anxiety and higher perceptions of competence and engagement in learning than students who are not intrinsically motivated” (p. 254).

**Effects of Extrinsic Rewards.** Research into the effect that various extrinsic rewards have on intrinsic motivation for learners has provided some interesting data that may be useful to the classroom teacher. The paper “Extrinsic Rewards and Intrinsic Motivation in Education: Reconsidered Once Again” by Deci, Koestner, and Ryan (2001) reviews prior and current research on this topic. Providing rewards to students for achievement has long been practiced, but is it effective, null, or detrimental to intrinsic motivation? Many teachers are familiar with providing rewards for student achievement, verbal praise, stickers and stars, money for making honor roll and a host of other extrinsic rewards. But are they useful tools for teachers? This article looks at a wide range of extrinsic rewards and analyzes whether the effect is to bolster or undermine students’ intrinsic motivation. This premise is supported by the work of Brooks, Brooks, and Goldstein (2012), when they suggest, “ it is our belief that practices predicated upon extrinsic motivation may, at times, actually work against students becoming more engaged with learning tasks or becoming more resilient unless features of intrinsic motivation are incorporated within the practices of extrinsic motivation” (p. 545). The theory that extrinsic rewards may undermine intrinsic motivation is not universally accepted by all researchers, “Accordingly, in the Fall 1994 issue of Review of Educational Research, Cameron and Pierce (1994) presented a meta-analysis of extrinsic reward effects on intrinsic motivation , concluding that, overall, rewards do not decrease intrinsic motivation” (Deci et al., 2001, p. 1).

## **Cognitive Evaluation Theory**

Cognitive Evaluation Theory or CET is an important theory when studying the effects of extrinsic reward. Deci et al. claim, “the effects on intrinsic motivation of external events such as offering rewards, the delivery of evaluations, the setting of deadlines, and other motivational inputs are a function of how these events influence a person’s perceptions of competence and self-determination” (p. 3). The authors point out that experiences that reduce one’s sense of self-determination and competence in performing a task are likely to undermine intrinsic motivation. Conversely experiences that increase a person’s sense of self-determination and competence in performing a task are likely to enhance intrinsic motivation. The authors look at extrinsic reward by breaking them up into two broad groups; the first being Verbal Rewards and the second being Tangible Rewards.

### **Verbal Rewards**

The authors use the term verbal reward to describe what would commonly be known as positive feedback. Intuitively we think of positive feedback as something that will undoubtedly produce positive effect on intrinsic motivation, and the authors agree, but not without some clarification. Verbal reward or positive feedback will likely enhance the sense of competency and as result increase a sense of intrinsic motivation, but it does depend on how the feedback is presented. Deci et al.(2001) suggest “verbal rewards can have a significant controlling aspect leading people to engage in behaviors specifically to gain praise, so verbal rewards have the potential to undermine intrinsic motivation” (pp. 3-4). The authors write that positive verbal feedback can be interpreted by the recipient as either informational or controlling; feedback given in a controlling manner is likely to reduce feelings of self-determination and is thought to reduce intrinsic motivation. Age was found to be factor in the effective use of verbal reward to

increase intrinsic motivation for students, “verbal rewards are less likely to have a positive effect for children than for older individuals” (Deci et al., 2001, p. 9). In general, verbal rewards are found to increase intrinsic motivation as long as they are not offered in a controlling way. When offering praise to students for quality work, Gutshall (2013) suggests, “praise for ability seems to undermine resilience and persistence, whereas, praising effort and suggesting ability can be improved appears to encourage resilience and persistence in school aged children” (p. 1073). In my own teaching career, I have provided this type of praise. I have told past students, “Wow, you are really good at shop work”, and realize now that I would be better to commend my students with following instructions well or that the hard work really paid off.

### **Tangible Rewards**

Deci et al. (2001) divided tangible rewards into three sub-sets:

Task-non contingent rewards, which do not require engaging in the activity per se but are instead given for some other reason such as simply participating in the experiment; task-contingent rewards, which require doing or completing the target activity; and performance-contingent rewards, which require performing the activity well, matching a standard of excellence, or surpassing a specified criterion (p. 4).

The expected result was that tangible rewards will be seen as controlling and as such a decrease in intrinsic motivation will be noted. The author’s conclusions supported this stance, although several noteworthy details justify further consideration. The sub group, performance-contingent rewards is related to student performance. To receive reward, certain standards must be met and this has the effect of undermining intrinsic motivation. It was noted however that high levels of performance or excellence results in “a tendency for performance- contingent rewards to affirm competence and, thus, to offset some of the negative effects of control” (Deci et al., 2001, p. 5).

Deci et al. (2010) note that, “expected tangible rewards did significantly and substantially undermine intrinsic motivation, and this effect was quite robust” (p. 15). These findings cast a shadow over the common rewards often provided students, the rewards intended to motivate may actually undermine intrinsic motivation which is frequently regarded as the strongest motivator for learning. While much research has pointed to the detrimental effects of tangible extrinsic rewards, there are still those that see it as a valid method of attempting to improve student motivation. Morris (2008) points to some recent attempts in Georgia to provide monetary incentives to struggling students, “In Georgia, the “Learn and Earn” initiative will pay \$8 per hour to high school students who are struggling in math and science to attend study hall for 4 hours per week” (p. 1)

### **Mindset**

While the forces that motivate students may be termed intrinsic or extrinsic or some combination of the two, another important factor in student motivation is mindset. While researching student motivation, I found several references to a theory called mindset, most frequently the reference was to Dweck (2006) and the book she authored, *Mindset: The New Psychology of Success*. Two mindsets are described in this book, fixed mindset and growth mindset. The fixed mindset describes someone who believes that their intelligence is fixed, that basically you cannot change how intelligent you are. Conversely, someone with a growth mindset believes that intelligence can be developed and improved through effort and hard work.

**Fixed Mindset.** The fixed mindset can cause all sorts of issues for students. A low achieving student can give up without effort, due to their belief that their efforts will do them no good. I can recall a recent group of students in my grade eight metal shop class. I started my class with a discussion on safety rules for machines and tools and then taught a lesson on

measurement. The very mention of having to do some rudimentary mathematics turned this group off entirely. Thirty minutes prior they were excited and chomping at the bit to get started building things and within seconds they had turned off and become disengaged. I had at table two a group of students that had not experienced success in mathematics and had decided that they were not going to be successful, so why even bother? I suspect that this group of students were of a fixed mindset and were willing to give up without trying. The fixed mindset is equally inhibiting for students that have been high achievers. These students at times can feel that one of the characteristics of “smart” students is that things should come easy, little effort should be required in order to achieve at higher levels than others. Effort to these students is something for those who are not “smart”; effort becomes a sign of failure. Chapter Two of Dweck’s (2006) book describes features of the fixed mindset, showing how limiting this can be,

From the point of view of the fixed mindset, effort is only for people with deficiencies. And when people already know their deficient, they have nothing to lose by trying. But if your claim to fame is not having any deficiencies - if you’re considered a genius, a talent, or a natural - than you have a lot to lose. Effort can reduce you (p. 42).

Students with a growth mindset know and relish the fact that to increase knowledge there will likely be failure. This is echoed in the work by Brooks, Brooks, and Goldstein (2012), when they note:

To recognize that making mistakes and not immediately comprehending certain concepts or material are expected features of the learning process. Students who persist when confronted with challenging learning tasks are those who believe that mistakes serve as the basis for future learning and that mistakes invite new learning strategies” (p. 543).

**Growth Mindset.** A growth mindset allows students to reach their full potential, with a growth mindset you believe that perseverance, effort and hard work can result in gains to intelligence, and learning. Students with a growth mindset are able to thrive when faced with challenge; failure is accepted as part of the learning process, which presents itself as a challenge to overcome rather than a reason to give up. When discussing students with growth mindset, Brooks et al. (2012) suggest that, “the successful student feels comfortable in taking the initiative and asking the teacher for assistance. They do not perceive requesting help as a weakness, but rather as an integral feature of the classroom environment” (p. 543). One of the most important things we can do for the students in our classes is to promote the growth mindset; it fosters a sense of resiliency and determination that helps to create lifelong learners.

### **Student Engagement**

One of the common staff room discussions for teachers of adolescents is the topic of student engagement, or as is frequently the case, the lack of it. According to the article on student engagement by Corso, Bundick, Quaglia, and Haywood, (2013), “research into student engagement and motivation reveals that up to 60% of high school students are ‘chronically disengaged’” (p. 51). Of importance to high school teachers is the claim Corso et al.(2013) make that disengagement actually increases as students’ progress from primary to secondary schools. All teachers would like to have their classes full of students that are motivated and engaged , but what does the term engagement mean? A definition is provided by Thijis and Verkuyten (2009) who state, “student engagement can be considered as the tendency to be behaviorally, emotionally, and cognitively involved in academic activities” (p. 268). While this definition must be meaningful to the authors, it does not provide the layperson with much clarity as to the meaning of student engagement. Kuh suggests, in the article by Axelson and Fick (2011), “the

engagement premise is straightforward and easily understood: the more students study a subject, the more they know about it” (p. 40). In addition, he describes engagement as, “the extent to which [students] take part in educationally effective practices” (p. 40). Corso et al. (2013) attempt to define the term student engagement and note that one of the problems when attempting to do so is that it is defined in many different ways by different researchers. One of the difficulties I have encountered in researching student engagement is that depending on the perspective of the researcher, the definition of engagement is either nebulous or inconsistent from paper to paper. An unpublished paper by Beirsto (2010) describes some features and characteristics of student engagement that I agree with. Engagement can be considered as part of the student teacher interaction, “to engage someone is to occupy the person’s attention or efforts” (Beirsto, 2001, p. 1), or it can be viewed from the student’s perspective, where, “to be engaged is to become involved, interested or engrossed” (Beirsto, 2001, p. 1). In attempts to define engagement, Axelson and Flick (2011) consider the Norman root of the word gage, which means to pledge, to commit to an action by oath. This suggests a serious undertaking that is not to be taken lightly. Beirsto (2001) concedes that the term engagement is frequently used to describe on task or compliant behavior, “but that does not automatically imply engagement, which requires a commitment by students” (p. 1). Mere compliance and appearing on task are really only a mild form of engagement. Beirsto (2001) further defines student engagement or commitment to learning as having varying degrees, depending on the intensity or level of commitment of the student. Beirsto names the increasing levels of student commitment as; compliant, attentive, connected, and at the highest level as impassioned. The four levels of engagement are not intended to be distinct and separate, but rather an overlapping continuum that shows gradual transition from one level to the next. As described previously, a student that

completes assigned tasks and participates in class activities may be described as engaged, but may not exhibit the characteristics of a student at the impassioned level of engagement.

The lowest level of engagement, compliance, is characterized by the students' willingness to participate and complete assigned tasks. Attentive engagement is realized when and if the student begins to develop a personal interest in the subject matter or the work being asked of them; this is an improvement over mere compliance, "but it tends to be volatile and its continuation may depend largely on the instructional materials and the teacher's behaviors. Continually having to stoke student interest can be a tiring business for teachers and can result in students expecting to be entertained" (Beairsto, 2001, p. 3). Unless learning activities become meaningful to the student, this really becomes the upper limit of student engagement. Connected engagement is where the students' learning becomes more personally meaningful, and the student may venture outside of the prescribed learning activities as designated by the teacher, the student becomes an active participant in the learning process. Impassioned learning is described "when the student begins to be motivated by internal interests and desires, and fulfilled by the experience of learning itself rather than by the expectations or praise of others" (Beairsto, 2001, p. 3). Unfortunately, I would suggest that the vast majority of high school students fall into one of the two lowermost levels of engagement. In far too many cases, students believe they are meeting expectations with merely being compliant, effort is a requirement on the part of the student, engagement cannot be seen as something a teacher can impart on a student. The student needs to take an active role if engagement is to progress further than mere compliance. This thought is echoed by Axelson and Flick (2011) when they state, "Clearly, students and institutions each have responsibilities for the quality of student learning. Students need to put forth the effort necessary to develop their knowledge and skills, and institutions need to provide

the appropriate environments to facilitate student learning” (p.42). How can we as educators make improvements to student engagement, when recent trends indicate that student engagement is declining? Baron and Corbin (2012) identify some of the familiar characteristics of disengaged students, “lack of class preparation, such as failure to read the assigned materials, disinclination to participate meaningfully in class, resistance to attendance requirements, resistance to active learning techniques, inability to concentrate, dependency on the lectures and lecturer to acquire knowledge” (p. 763). Surprisingly this description of disengaged students was for Australian university students, not a group of adolescents at the local high school. It seems that student engagement is an issue that is not isolated to only North America.

### **Improving student motivation and engagement**

When it comes to student motivation and engagement, there are no easy fixes or ‘one size fits all’ solutions. Projects and lessons that engage students to a high degree may work for some students, but fail to achieve similar results with others. Research has shown that both intrinsic and extrinsic motivation can play an important role in student motivation. While intrinsic motivation is seen as a more desirable and effective motivator in students, it must be acknowledged that many tasks that students are asked to engage in are not intrinsically motivating. When providing feedback to students, it is important to praise students for hard work, diligence, and creativity rather than merely praising them for doing good work or being adept at a task. Verbal rewards, although an extrinsic motivator can be effective, particularly if it is provided in a supportive fashion that bolsters the students’ sense of autonomy.

One of the suggestions made by Corso et al. (2013) to improve classroom interaction with students with the aim of improving student engagement is to provide adequate teacher expertise in the subject matter they are to deliver. The authors maintain that “when teachers

demonstrate expertise in both their content area and their craft, students are more likely to respect them. A classroom marked by mutual respect is more likely to be engaging to students” (p. 58). This is an interesting suggestion that although intuitively understood, is difficult to enact in actual practice. With the budgetary constraints facing education today, every school has teachers that instruct outside of their area of expertise. Technology Education teachers, unless having come from industry, are only trained as generalist teachers and are expected to teach whatever subjects are assigned them. I have been teaching shop for fifteen years and only in my latest assignment in the past four years have I taught in my area of expertise.

I think that one of the most important things that can be done to improve student motivation and increase student engagement is to impress upon our students the importance of the growth mindset. A growth mindset promotes the ideal that we can with effort change or improve our intelligence, that failure is not a reason to give up and that hard work and effort is not a bad thing.

## **Chapter Three: Project**

### **Student Belt Grinder Project for Engagement and Motivation**

It has been my desire throughout this master's course to design and document a practical project that would have the potential to increase student engagement and motivate my students to succeed. During my past fifteen years as a technology education teacher, I have taught a wide range of shop courses, including: junior, intermediate, and senior woodwork and metalwork; power technology; automotive mechanics; engineering; science and technology; as well as robotics and electronics.

My most recent teaching assignment has been dedicated to the metal-shop and that is where I decided to focus my inquiry for this final master's project. My search of current literature around the topics of student engagement and motivation suggested that it is the senior students in our high schools who suffer the greatest from disengagement and lack of motivation (Ryan and Deci, 2000; McGeown et al., 2013; Meece, Anderman & Anderman, 2006), something that my own experience corroborates. Consequently, I put a great deal of thought into selecting and developing a project that would motivate senior students throughout the building process, challenge them to learn new skills, and allow them to feel pride and satisfaction upon project completion. The project I decided to develop was a 2" x 72" variable speed belt grinder.

Chapter three is divided into several sections that outline the choices and decisions I made while developing this project. The first section outlines the attributes that make the belt grinder a good project from the standpoint of student motivation and engagement. This is followed by a section that examines how to foster student motivation and engagement through project selection and design, and investigates my own

motivation as an instructor. The final two sections summarize my thinking and the steps I took with regards to belt grinder material choices and features, in order to ensure the project would be accessible to students at the high school level; these sections describe the scaffolding strategies I included to help students take on a challenging project without getting so frustrated that they give up.

### **The Belt Grinder Project**

The following section will outline why I chose this particular project and how I used my own experiences and what I learned from my literature review to develop this project in order to maximize student engagement and motivation.

**Why choose a belt grinder?** In my experience, technology education teachers face a significant challenge in selecting appropriate student projects; shop programs can flourish or wither based on the quality of the projects offered and whether they engage students. One of the projects offered in my Introductory Metalwork course is a handmade knife; students can craft a high quality custom knife of their own design. The students use a good quality tool steel, and cut out the profile on the vertical band saw, refine the shape with grinders, hand file the blade bevel, harden the blade using an oxyacetylene torch, and temper the blade in an oven. The knife scales and rivets are epoxied in place and the handle is hand sanded and finished with Tung oil. The results can be spectacular, with both students and parents pleased and proud of the results. Students in the grade 8 metal-shop often ask when they will be able to make knives. Why is the knife project so popular? Likely for a variety of reasons, but one reason often cited by students is that a knife is something they can use. Many of my students enjoy the outdoors, and they can actually use their class project when they go hunting or fishing.

Students who take the Metalwork Development course (a senior level course) start the term working on a prescribed project, and when they complete this, they may take on a project of their own choosing. Frequently, they want to make another knife, but this new belt grinder project could present another viable option for an interested student. The student has already used a belt grinder in the shop and knows what it can do for them, likes what it can do, and consequently develops a strong personal connection to this project. A constant reminder of what they are working on is the frequent use of the commercial version of this machine in the school shop. The 2 x 72 belt grinder is one of the most used machines in our metal-shop; it is powerful, versatile, and a pleasure to use. This is a significant feature of what the literature describes as “connected learning,” where the students’ learning becomes more personally meaningful (Beairsto, 2001).

Starting out. The seed for this project was sown several years ago when one of my students asked to build a belt grinder. I thought it was a good idea and I encouraged the student to proceed with research into the design. I did some research of my own and found many online building blogs and several plans posted on the internet. To my disappointment, the student reported back that despite spending hours searching he could not find any plans or designs that could be copied. A quick search on my part uncovered some viable plans and construction began. While the plans were relatively complete, construction details were lacking and there were several design flaws that became apparent during the build. I quickly realized the student was not likely to be successful without a significant amount of assistance on my part. The student did not have the necessary machining experience and in many cases could not or would not make the necessary effort to problem solve. Forward progress halted until I could make myself

available to assist the student. I often had to machine or fabricate the parts before the student attempted the same procedure in order to troubleshoot and provide procedural advice. The student did a good job of manufacturing the necessary parts, but in the end, the project was never fully assembled and was taken home in pieces (I am uncertain whether the project was ever fully assembled). The student most certainly gained knowledge and experience in many facets of metalworking shop practise, but ultimately did not go home with a fully completed project, and as such I would consider this attempt at machine building less than successful.

### **Motivation and Engagement**

The following section will look at how issues around student motivation are addressed by providing sufficient scaffolding to ensure the student does not have to take on tasks they are not prepared for. In my experience, students at the high school level do not have the experience or resiliency to take on a project of this nature where all details have not been sufficiently explored and resolved by the instructor. In addition I will look at my own motivation for creating this project which includes the opportunity to share this resource with other technology education teachers.

**Student scaffolding.** Designing and building a belt grinder is not easy. Very few students possess the necessary skills, experience, and resiliency to take on a project of this scope without help and I have only very rarely had students who have had success taking on such a challenging design and build project independently. My experience with the aforementioned student who took on this project was that he would have required a great deal more scaffolding in order to be able to successfully complete his own belt

grinder. To make this type of project viable, I needed to create a cook-book resource for my shop - with all of the instructions and guidance a student would likely need.

I feel that a project of this level of complexity, in order to be attainable by most students, must be fully developed by the instructor. There are so many details that must be dealt with in order to be able to provide adequate support for the student to be successful. Without having gone through the process of building the belt grinder prototype, it would be difficult for an instructor to provide the student with the needed individualized project guidance and additional support to resolve complicated build issues. Today's larger class sizes effectively reduce individual teacher-student contact time making projects requiring significant amounts of one on one time unworkable. Thus, for a project like this to be successful, proven plans and instructions need to be in place, and all materials must be available; ready for the student to see the project to completion relatively independently.

While I was creating the design and instructions for the belt grinder, I had to be aware of a number of things. Firstly, as an experienced machinist, I have to be conscious of the fact that tasks that I think are quite simple may in fact be extremely challenging for students. This was one of the main considerations while I designed the project itself and created the procedural instructions to make the component parts. When time allows, I plan to further develop this project guide with a series of instructional videos to further support student learning. None of the parts to be manufactured require techniques that fall outside of those commonly used in most high school metalworking shops. While a student may be overwhelmed with the project as a whole, I have broken the build into component pieces, none of which are overly challenging parts to manufacture. In

addition, students will be encouraged to take on simpler parts at the start of the build in order to build confidence and skill prior to taking on some of the more challenging pieces. I also had to be aware of necessary equipment. The basic equipment needed for this project (engine lathe, drill press, milling machine, and electric arc welder) are also commonly available in high school shops.

It has been my experience that students can quickly lose motivation, or as I call it, “inertia.” In order for a project of this scope to succeed, it is best that there be as few reasons as possible for a student to cease forward progress. A project such as this one has many varied component parts that don’t need to be manufactured in any particular sequence. They require varied shop tools and processes, which provides the student with little reason to halt progress; if the lathes are all being used, the student can start a component that requires the milling machine, or the band saw, or the welder.

I have discovered in my own teaching practise that what motivates or engages some students will not motivate or engage others. This observation was reinforced during my search of current literature pertaining to student engagement and motivation (Thijs & Verkuyten, 2010). However, my own experience has shown me that many students, like me, find hands-on projects to be very engaging and, as such, they are motivated to work hard and complete them. It is my hope that the belt grinder project will provide this opportunity for these students.

Motivation to give back. Throughout my teaching career I have been able to use resources created by other teachers to assist me with the courses I have taught. Particularly as a new teacher, having resources available to assist with what at times has been an almost impossible amount of preparation for teaching new courses or unfamiliar

material was a lifesaver. I am sincerely grateful to those who made teaching resources or materials available to myself and others.

I have at times been asked by colleagues for assistance with course material and have provided it, but often with the disclaimer of “this is what I use, but it’s not very good.” I have found that it is quite common for teachers to make apologies for the resources they have created. We as teachers never seem to have adequate time for lesson planning or preparation and as a result we sometimes wish we had more time to polish or develop our materials. In addition to actually enjoying designing and building this hands-on project, I felt very strongly about being able to give something of value back to my colleagues. Working on this master’s project has afforded me the significant amount of time needed to put together a resource that I think other metal-shop teachers will see as valuable and useful as a teaching resource, and I look forward to being able to share it with others.

### **Belt grinder project design choices**

Which belt grinder? There are many variations of the 2 x 72 belt grinder that are both commercially manufactured as well as shop-made by individuals. I thought a lot about which design to proceed with, and after a considerable amount of time researching and sketching possible builds, I decided on one of the most popular and versatile designs: a Beaumont Metalworks KMG clone. The entire project can be fabricated from readily available steel stock, is very versatile, and does not require overly complex machining or Computer Numeric Control (CNC) capability.

The commercial versions of this machine are expensive; at approximately \$2000 to \$3000 purchase price, they are far too pricey for most students to consider for home

use. I have spent considerable time researching, designing, prototyping, and creating a shop-made version of this excellent machine tool. In my opinion, the shop-made version is every bit as good as the commercial versions available, but significantly more affordable. The basic machine can be fabricated for a cost of approximately \$150 and the cost to power it can range according to the needs and resources available to the student. An electric motor of no less than 1 horsepower is needed, and costs to power the grinder can range from free to over six hundred dollars if a three phase motor and Variable Frequency Drive (VFD) are used.

Adaptable design. One of the suggested parameters for this project was that it should be useful to our peers, which in my case is other shop teachers. With that in mind, I have outlined some to the technical details of the particular belt grinder design I have chosen to develop. This will be divided up into three parts, the first discussing the versatility of the modular tool arm design, followed by a paragraph that considers build cost, and lastly one that looks specifically at options available to power the grinder.

Modular tooling arm. One of the desirable features of this type of belt grinder is the modular tool arm design that allows for a variety of adapters for a wide range of tasks. A flat platen that includes a solid tool rest may be used to flat grind knife bevels and for general grinding and de burring of parts. The flat platen has been designed to be removable, which provides what is known as a slack belt grinding capacity. Slack belt grinding with a fine abrasive belt is an outstanding setup for sharpening knives. The two inch diameter wheels on the top and bottom of the flat platen can be used as contact wheels when a 1 inch radius is desired. Tool arms can be easily made to allow a variety of different contact wheels to be used. I have not included it in the construction notes, but

I have sourced an inexpensive ten inch diameter rubber bonded contact wheel that can be fitted with sealed bearings to provide a large diameter contact wheel which is particularly useful for hollow grinding blade bevels. The contact wheel I have sourced can be completed with bearings for a cost of approximately \$140 compared to \$300 for a commercially available version. Again a significant cost saving can be achieved with shop-made parts. Smaller contact wheels are a popular addition to commercial 2 x 72 grinders, and again shop-made components can be fabricated at a significant cost savings. I have re-purposed some six inch diameter rubber tread castors by boring the hub for sealed bearings and truing the outside diameter on the lathe to make a 5 inch diameter contact wheel that costs the student \$12 compared to \$60 for commercially available wheels. Small wheel adapters are a very useful feature to grind finger grooves and other small radius features of knives; again, I have developed a very inexpensive method of converting small woodworking spindle sander drums to this application for a fraction of the cost of the commercially available counterpart. One of the great features of this belt-grinder design is its flexibility with regard to features, cost, and build complexity.

Building costs. This project is only offered as an option for students, as it is too expensive to be considered as a project for students as part of their regular course work. Operating budgets for our shop programs have been cut back in recent years, while costs to maintain and operate our shops continue to rise. However, efforts were made throughout the entire design process to keep costs to a minimum without compromising the high quality nature of the end product. One of the largest costs incurred with a belt grinder project is the cost of the turned parts, drive wheel, tracking wheel, contact wheels, and step pulley. Manufacturing these parts in-house rather than purchasing them from the

many vendors that supply them saves considerable money. The basic frame or chassis for the grinder would be much simpler to make if it were manufactured from cold rolled mild steel rather than hot rolled mild steel. Cold rolled mild steel has square finished edges and a clean surface devoid of mill scale, but it is approximately three times the cost of hot rolled steel. I have designed the project around hot rolled steel because of this; it requires a few extra steps in the machining process, but the cost savings in my opinion are worth it.

Motor and Drive Options. Depending on student preference and financial means, there are a variety of options that may be exercised. Perhaps the biggest cost of this project is the choice around what sort of electric motor is to be utilized. Variable speed is a desirable feature for this type of belt grinder, and there are several ways to accomplish this. The simplest is using an AC electric motor and a pair of step pulleys to vary belt speed. With an 1800 RPM electric motor and a 4 inch diameter drive wheel, the 4-3-2 step pulley will provide abrasive belt speed of 936, 1872, and 3,744 surface feet per minute. This is the speed provided by my prototype model and it provides a very useful range of operating speeds. If faster cutting speeds are desired, a larger drive wheel can be manufactured to increase belt speed. The step pulleys are readily available commercially, and purchasing a pair from a vendor is certainly an option for a student who feels the step pulley is too demanding a machining task. Variable drive speed can be provided by other means, the most desirable of which is to power the grinder with a 3 phase electric motor and then vary motor speed through the use of a variable frequency drive (VFD). The VFD electronically converts single phase input power to three phase output power. It is

also capable of varying the frequency of the output which is what can provide variable speed for a three phase motor.

### **Instructional Material**

I devoted significant effort to creating an instructional manual or “cookbook” as it is frequently called in technology education, to help the student with the construction of each of the component parts of the belt grinder. Due to the complexity of the finished product, the entire project is divided up into thirteen individual cookbooks that make up all of the component pieces. In the following section, I will look at some of the features I incorporated into each of the cookbooks, and will conclude with one example from the cookbooks I have created.

**Creating a cookbook.** This was one of the more time-consuming elements of this design and build project for me, as I not only had to build what represents a full term’s worth of project work for a student, but also try to create a project path that students will be able to follow relatively independently. I not only had to think of how I would make the part, but also whether a given strategy was likely to be successful for my students. At times I had to stop and either purchase or make special tools to continue with the project. As the parts were being manufactured, I took detailed notes of the procedures. I wanted to make sure that the myriad questions students will have when making these parts are answered in the cookbook; for example, what speeds and feeds, drill bit sizes, and of course sequence and set up of the various operations. While I was machining parts, I would stop to photograph the operation in order to have pictures to accompany the written text. In addition to having pictures and step-by-step directions on how to make

the parts, I needed to have component drawings of each part. I had hoped to make CAD drawings of each part, but due to time limitations was unable to do so and instead drafted them by hand. In order to include the hand-drafted component drawings, I copied each drawing as a PDF and inserted the image into the appropriate document.

Important features. Keeping student motivation and engagement in mind, there were a variety of design features that I incorporated into each of the component cookbooks. I started the cookbook for each of the belt grinder parts with a photograph and a general description of the component in italic font to provide an overview of the function of the part. The cookbooks were further broken down into subsections where a basic description of the next sequence of procedures began. I wanted the students to be clear when they start a component where the part fits into the belt grinder assembly and what it is for. I know from personal experience the frustration one feels when you are building a part and you don't know exactly what it does; therefore, it is good to provide some amount of context for each part.

I made sure to include many photographs in each cookbook. Personal experience has shown me that cookbooks that only contain text and do not include clear photographs of procedures are not well received by students. In addition to the photographs, I added text to the photos to provide further detail. Photos add clarity to the text and often allow students to continue without having to wait for instructor assistance. I have found that one of the biggest issues for students in shop class is having to wait for instructor assistance, students are often quick to lose motivation when they have to wait for help. The photographs in the cookbook are all taken using the same equipment and tools the students will be using when making the parts.

If a specific safety or equipment caveat was needed, I highlighted this text in red to draw the students' attention. I was careful to employ this strategy judiciously as it would lose effect if used too frequently.

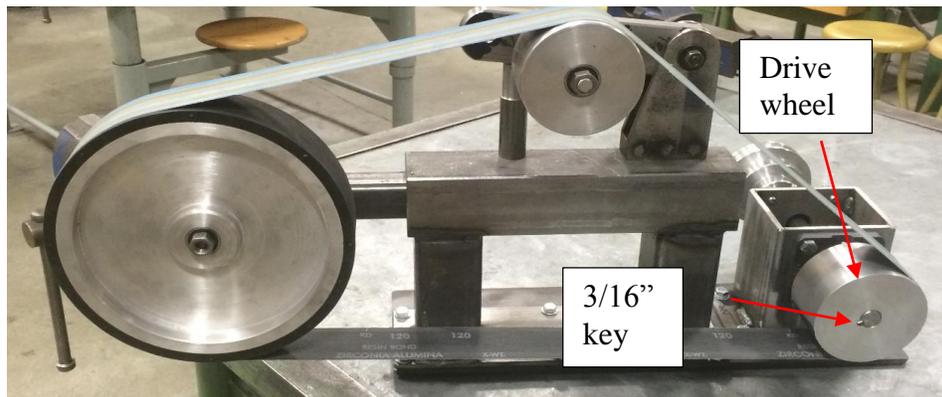
My experience has shown that students in shop class are often not interested in reading large quantities of text, and I kept this in mind while creating the cookbooks, and tried to keep the instructions succinct and to the point. I did at times attempt to include some descriptions of tools or procedures that they were not likely to be familiar with, but again tried to keep it to a minimum. I made efforts to include some amount of white space on each page, attempting to create an uncluttered appearance and allowing room for student or teacher notation.

The following is a sample of one of the component part cookbooks for the belt grinder project that was created to foster student motivation and engagement.

Example: Drive wheel cookbook.

### Drive Wheel

*The  
drive  
wheel  
will be*



*keyed to the 3/4\" driveshaft of your belt grinder. The drive wheel must be accurately machined, the outside diameter must be concentric to the bore, it will have a 3/16\" keyway broached in the bore, and it will have a crowned outside diameter to ensure the abrasive belt does not wander.*

1. Cut off a 2-1/2" long piece of 4" 6061 aluminum round bar.
2. Use a hex key to reverse the jaws in the three jaw chuck.
3. Use a dial indicator to help true up the OD of the round bar in the chuck. You should be able to limit radial run out to less than 0.005". This is an especially important step if the cut off saw has not made a very square cut.

Notice the jaws have been reversed to accommodate 4" diameter part.



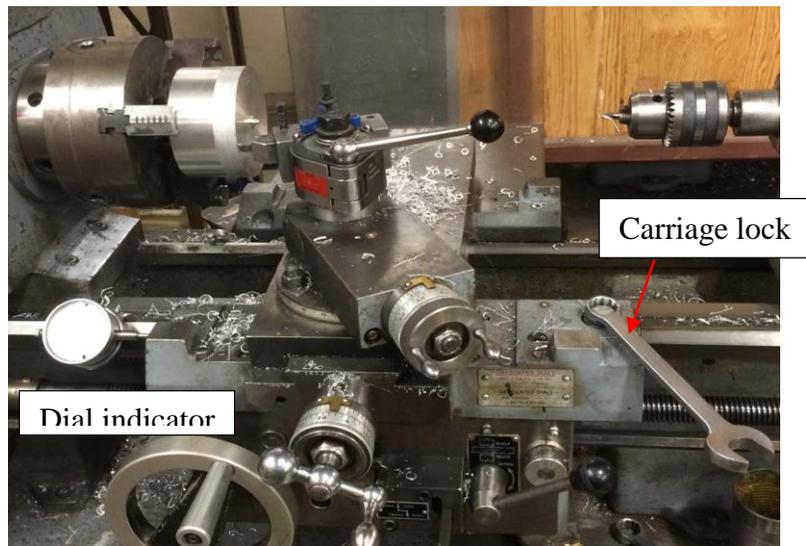
4. Set up a left hand facing tool and face the end until it cleans up. Lathe RPM of 450 and a feed rate of .007" per revolution will work fine. Remember that cross feed is half that of longitudinal feed.



5. Clean up the OD of the part, you should not need to take off more than 0.015" to clean up. **Be careful here, you need to be mindful of the inverted lathe jaws, don't run the cutter or tool post into the spinning jaws!** Use a lathe file to de burr the sharp corner.



6. Remove the part from the chuck and reverse. Press the faced end into the back of the lathe jaws. Face the part until finished length of 2.250" is reached. Use the mag back dial indicator to accurately



advance the carriage. Snug the carriage locking bolt on your last pass to ensure the carriage does not push away due to cutting pressure.

7. Set up the right hand turning tool and clean up the OD. De burr with a file.

*Next you need to very accurately machine the bore to finished size which is 0.750" or 3/4". You will use a reamer to accurately size the bore. A reamer is only designed to remove a small amount of material, you must drill to within 0.015" of finished diameter in order for an accurate bore to be produced by reaming.*



8. Center drill, then 1/4" drill bit, 5/8" and finally 47/64" (0.734") drill bit. You will need to decrease the lathe RPM as you increase in drill diameter.

Center drill -900 RPM

1/4" - 900 RPM

5/8" - 450 RPM

47/64" - 200 RPM – use slow feed and some cutting oil won't hurt.

9. Check drilled bore with digital caliper, how does the bore compare to the actual drill bit size of 0.734"?

This is why we don't just drill with a 3/4" drill bit and call it done, a drill bit will often drill oversize.

10. Finish ream the bore.

100 RPM, use cutting oil, low feed pressure, and frequently back out to clean out chips.

*Caution – Do not ever reverse direction of rotation when using a reamer, if you run the reamer backwards (counter clockwise rotation) you will ruin the reamer!*

11. *De burr the bore using the modified triangular file scraper as shown by Mr. Feustel. You do not want a burr that will cause a problem on the next operation which is pressing the drive wheel onto a tapered mandrel.*

*Now that you have an accurately sized bore, you need to make sure that when it is spinning on the drive shaft at high speed that the outside diameter is perfectly true or concentric to the bore. If it is not, the drive wheel will appear to hop or bounce around when it is spinning on the drive shaft, not acceptable. When the bore and the outside diameter are turning around a common center, this is what is known as being **concentric**. You are going to press the drive wheel onto a tapered mandrel and turn the OD concentric to the bore between lathe centres.*

12. Before pressing the drive wheel onto the tapered mandrel, clean the bore with compressed air and a rag to make sure there is no debris or burrs in the bore. The tapered mandrel has a big and a small end. The big end is the one with the +

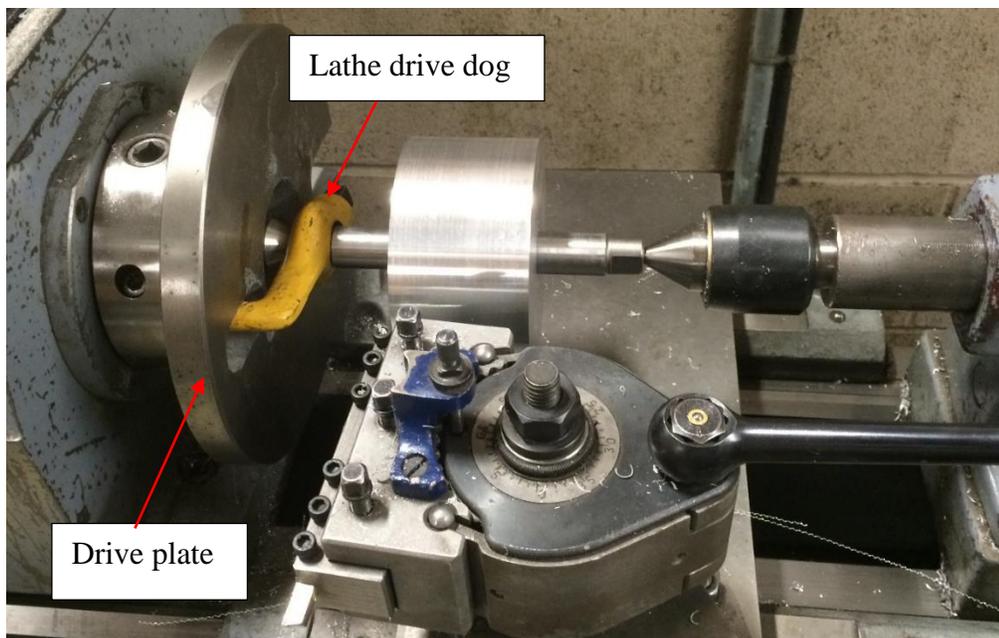
marked on it. You must push the drive wheel towards the + end of the mandrel with the arbor press to wedge it securely in place.

13. Set up the lathe by removing the existing chuck and replacing it with the drive plate. Clean and insert a tapered sleeve and dead center into the headstock end of the spindle. You should have a revolving live center installed in the lathe tailstock.

14. Tighten the appropriate size drive dog on the + end of the tapered mandrel and position the work piece between centers, engage the drive dog in one of the lugs of the drive plate and snug the tailstock. Spin the drive plate to ensure no wobble or binding. Always try to machine with the cutting force pushing against the big end of the mandrel.

15. Set up a right hand turning tool and clean up the OD.

450 RPM - .007" / rev feed.



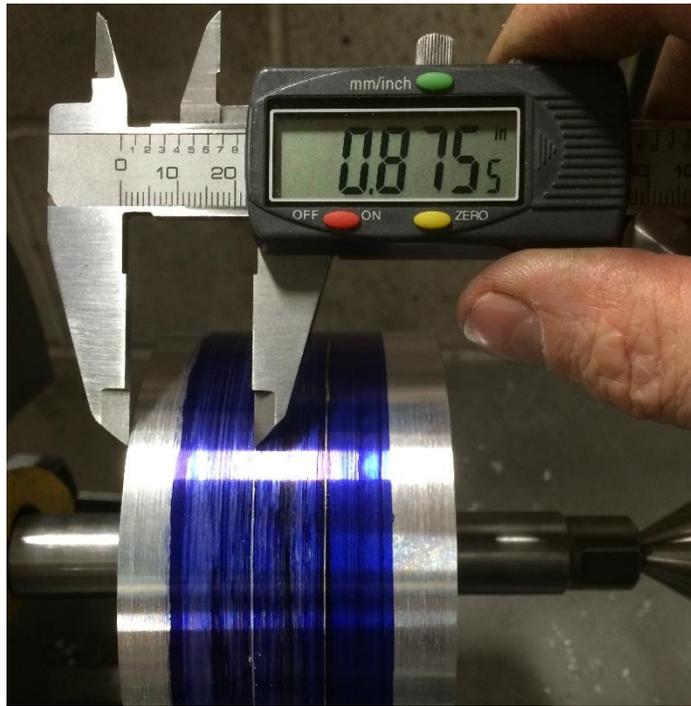
16. Use some felt pen or layout blue to mark the drive wheel blank. Use digital caliper to make reference lines leaving  $\frac{1}{2}$ " between the lines.

$$2.250'' - .500'' = 1.750''$$

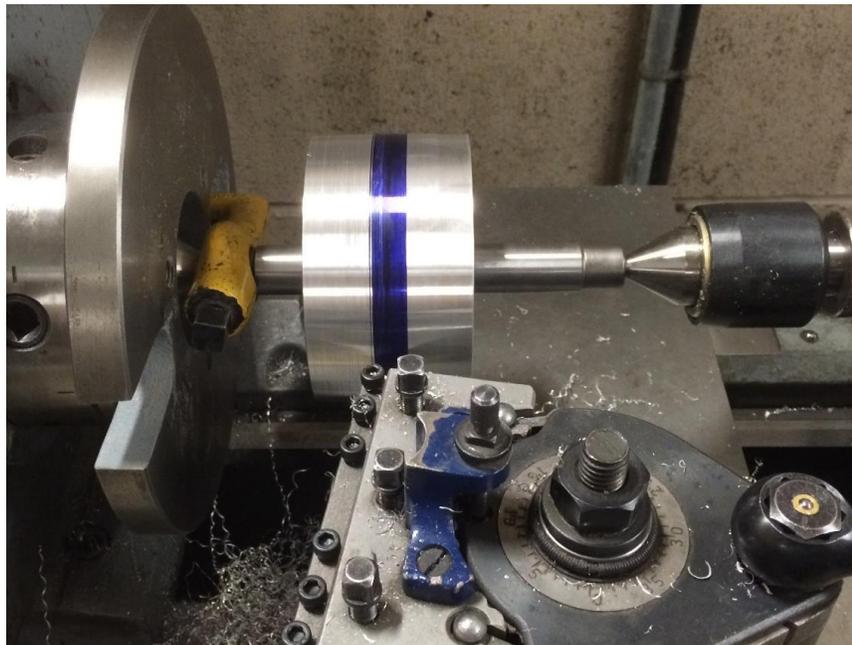
$$1.750''/2 = 0.875''$$

17. Set the compound to cut the  $1\text{-}1/2^\circ$  taper.  $90^\circ$  is parallel to the spindle axis.

$$90^\circ - 1\text{-}1/2^\circ = \mathbf{88\text{-}1/2^\circ}.$$



18. Set up a right hand turning tool to turn the taper to the layout line. To turn the taper, you will not be able to use the power feed, instead you will have to use the compound feed hand wheel.



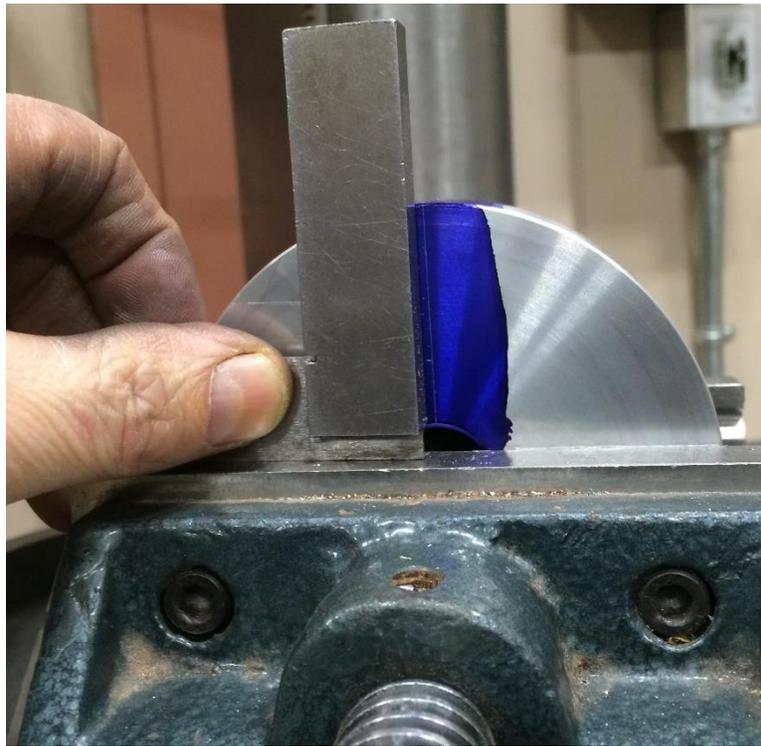
19. Remove the drive wheel, flip the part and press back on to the tapered mandrel. Remember the end with the + on it is the big end!
20. When you have finished machining both sides of the taper, remove the tool post, chamfer the edges with a lathe file, and polish with emery cloth.

*Next step is to drill and tap for a set screw and broach a 3/16" keyway which will serve to secure the drive wheel to the drive shaft.*

21. Scribe a centerline across the back of the drive wheel with a combination square and the center finding head, layout blue makes your layout line easier to see. Transfer the center line across the crown of the drive wheel with a scribe and a machinist square. Now mark the center of the drive wheel using the height gauge. Center punch this intersection.



22. Set up the drive wheel in the drill press vice, use a machinist square to make sure the scribed line will be parallel to the drill press spindle.



Center drill, then drill with the correct tap drill size clear thru to the bore of the drive wheel. The correct tap drill size for the 1/4-NC thread is a 13/64" drill bit. On our gear head drill press, the correct speed to use is 1070 RPM.

23. Install a 17/64" drill bit and drill a clearance hole 3/4" deep, and remember to countersink before tapping the hole.
24. Use some tapping oil to lubricate the tap, and thread the drive wheel as far as you can. Blow the chips out with compressed air.



25. To broach the keyway, you need to start by inserting the  $\frac{3}{4}$ " diameter bushing into the bore. Line up the drilled hole with groove in the bushing, you want the set screw to contact the key not the drive shaft.

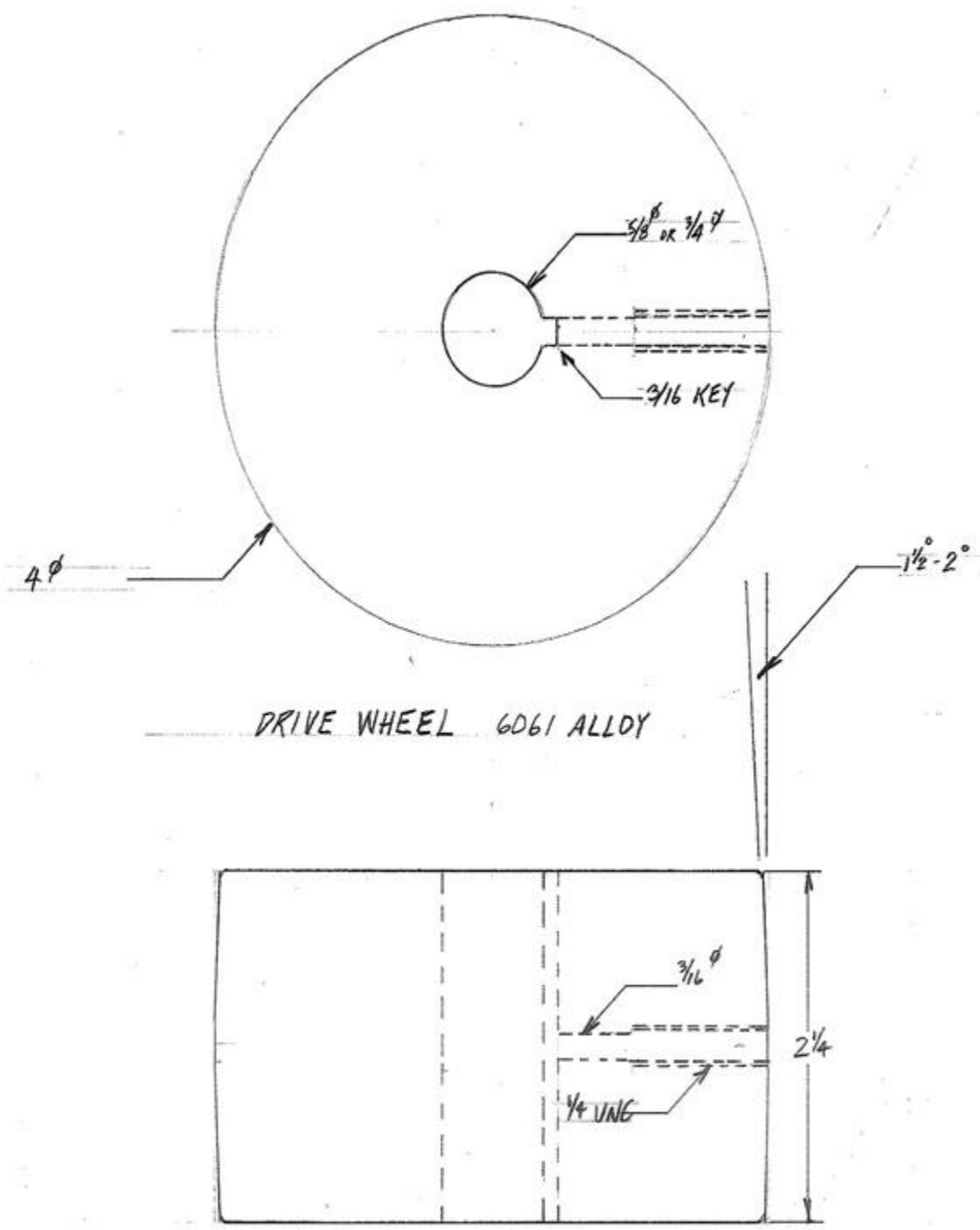


26. The broaching operation takes 4 passes;

1<sup>st</sup> pass broach only.  
 2<sup>nd</sup> pass with thin shim.  
 3<sup>rd</sup> pass with thick shim.  
 Last pass with both shims.  
 Use cutting oil to lubricate the broach, and remember to clear the teeth of aluminum chips before each pass.

Wipe down the broach and shims and return to the storage case. Wipe down the drive wheel and blow any chips from the threaded hole. Good job, the drive wheel is done!





## **Conclusion**

Student motivation and engagement or the lack thereof are terms that are often discussed when talking about high school education. While motivation can be defined, it is difficult to know what will motivate one person compared to another. Creating a project that will motivate an entire group of students seems at best improbable, which is one of the reasons I have created this belt grinder project. The project is not intended to suit an entire class, nor is it a suitable project for an entire class to take on. I always try to design projects that will engage as wide a student group as possible, but find this task easier at the grade eight level than with senior students, as research has shown that student engagement and motivation wanes as age increases (Ryan and Deci, 2000; McGeown et al., 2013; Meece, Anderman & Anderman, 2006).

While I recognize that the belt grinder project is not suitable for all senior students, I did make every effort to use the research about motivation that I had read to make this project as accessible and engaging for students as possible. My goal has been to produce a document that allows the student to stay motivated for an extended period of time while working on a single large project goal. This project provides scaffolding for the student such that they should be able to make tangible daily progress towards a completed project, providing a better chance that the student does not lose the necessary inertia to complete the project. The whole project is made up of many smaller components that utilize a variety of different shop equipment, thereby allowing student flexibility and capacity to proceed even when challenges arise with access to equipment. I made sure the step by step instructions and images were thorough, clear, and easy for students to use. Through my research of some of the literature on motivation, my own

observations of students' motivation in my classroom, and an examination of my own motivation throughout the course of my development of this project, I have gained some insight into what motivates people, particularly students, to engage in their own learning. I have been able to apply this theoretical knowledge to the development of this and hopefully future hands-on projects.

## **Chapter Four: Reflection**

### **Project Summary**

The goal of this master's in education project was to study factors influencing student motivation and engagement with a goal to design hands-on projects to engage and motivate students in the field of technology education. Motivation and engagement are critical issues that are important concepts for educators to consider when they are designing coursework and important for shop teachers when designing hands-on projects for students to build. With this information in mind, I have designed, built and created a cookbook to build a 2x72 variable speed belt grinder. The resulting project cookbook is intended to guide a senior metalworking student through the process of building a high quality variable speed belt grinder suitable for general sanding and grinding of wood, metal and plastics. This project provides the student with a broad exposure to a variety of hand and machine tool processes commonly found in a typical high school metal shop.

### **Reflecting on my own motivation.**

While my master's inquiry was focussed primarily on student engagement, my own motivation to create the physical belt grinder and accompanying student instruction booklet is worth considering. While it would have been considered acceptable to create only the reflection document, I felt very strongly that I also had to create the physical products (the belt grinder and cookbook). I did not keep accurate records of the amount of time I put into these projects, but between research and design, prototyping of parts, photo-documentation of the build, creation of the cookbook, and drafting of the component parts, the time devoted was significant, likely in excess of one hundred hours.

I have yet to have a student complete this project, but I expect a high-school student will also need one hundred hours to build the actual project.

I struggled with my own motivation completing much of the course work for this master's in Curriculum Studies programme. Most of the required work has been of an academic and theoretical nature, little of which I have found enjoyable or immediately relevant to my teaching practice; therefore, my own motivation for completing much of the course work has been extrinsic rather than intrinsic. The promise of the completion of the M.Ed. degree and the associated benefits has provided me with the motivation to carry on and complete the required assignments. With few exceptions there has been little intrinsic motivation to engage in the course material; while I liked the people I studied with and the instruction was of a high calibre, I just didn't find most of the material studied to be personally engaging. Current research has supported my own observations, namely that although extrinsic factors can be strong motivators, they are not as desirable as having strong intrinsic motivation to engage in and complete tasks (Ryan and Deci, 2000). In my own situation, this extrinsic motivation and a strong desire to finish what I have started, has been enough for me to complete the required work, but for many of our students in schools, a lack of intrinsic motivation would likely result in a lack of successful outcome.

Although I struggled with a lack of intrinsic motivation while completing much of the required master's coursework, I did not suffer the same lack of motivation when completing the practical or hands-on parts of this project. The difference in enthusiasm, effort, and ability to stay on task while completing the hands-on components was a significant contrast. I was enthused and engaged while designing, fabricating,

assembling, and documenting the belt grinder project. I found the activity to be engaging and enjoyable not because I wanted to complete a course requirement or because I knew I would receive financial remuneration upon completion, but because I really enjoyed the work I was doing. This is in fact an excellent illustration of intrinsic motivation: I engaged in the work that had to be done because I enjoyed it. I did not need an instructor to continually encourage my interest in the activity. On my own, I achieved what is considered the highest level of engagement, and my research on engagement suggests I would be considered an impassioned learner (Bearsto, 2001). Instead of procrastinating and dreading the work, I looked forward to it, striving to do my best and willingly putting in long hours to complete the required task.

### **Giving something back.**

A significant motivation for me while working on the project component of this master's coursework, was the prospect of being able to share a significant piece of work with my colleagues. I have been appreciative and thankful many times in my teaching career of the generosity of colleagues being willing to share teaching resources and project ideas, and am excited to be able to share what I think is a useful teaching resource with others that are interested in teaching metal work. I hope other technology education teachers will be interested in using this belt grinder project in their metalwork classes. Conceiving of, designing, building, and documenting a project of this scope was a significant undertaking, and it would not likely have happened were it not for the requirements of this master's program. I plan to make these project plans available to any shop teachers that would find them useful; I anticipate facilitating a workshop where I can share my project plans with other shop teachers at the annual British Columbia

technology education conference, and also plan to post the project plans in the resources section of the BCTEA website.

**What aspects of your professional thinking, beliefs, intentions or activity have changed and which have been re-enforced as a result of your experiences throughout your MEd program?**

While I have struggled with the highly academic and theoretical content of much of this MEd program, several important considerations have arisen as a result of my studies. Firstly, I am highly appreciative of the cohort model that has been employed by this programme; I have enjoyed the interaction with a group of intelligent and creative colleagues. The group included several teachers that also teach in my area of specialty, technology education, but many more from a wide range of other teaching areas. An important part of my growth throughout this programme has been this new contact with colleagues, from varied backgrounds. This interaction has been a valuable reminder of the value in collaborating with others, sharing ideas and opening my mind to new concepts. It is far too easy in our busy professional and personal lives to become isolated, something that does little to promote personal and professional growth.

The use of technology, particularly the use of teacher-produced video has been bolstered by my experiences over the past two years. I had considered producing instructional video for quite some time, but had not endeavoured to do so until prompted by one of the courses in this programme. Like most new technology, there is an initial investment in time and effort that must be put forth before even a modicum of competency can be realized, fortunately one of our assignments dovetailed well with the exploration of new to me technology and the effort was put forth. I now feel competent in

producing and editing instructional videos, and these have become a new tool in my teaching practice.

Our summer course that looked at environmental education reinforced the importance of our environment and the critical role it plays in our day to day lives as teachers and the lives of our students. While I feel preserving our natural areas and environment is important, it wasn't something I would previously incorporate into my lessons and interactions with students at school. Our course work has encouraged me to bring up the topic of environmental awareness and stewardship where I can, I feel even small efforts in this regard can make significant impact to students' thoughtfulness about the environment.

**Lack of relevant literature regarding technology education in research.**

Something that has plagued me throughout this entire master's programme has been the absence of current research which relates to technology education; when you search on Technology Education, you will find a great deal of information and research on computer technology, but a decided lack of material on Technology education. This lack of resource material has proven to be extremely challenging, as a significant part of this master's programme and certainly a large part of the final project has been based on the review of current academic literature of your chosen area. I had to make some very difficult decisions with regards to choice of topics as a result of this; trying to find a topic that I felt I could somehow find adequate research in order to satisfy the literature review component of the course work. The result being doing a significant amount of work on two literature reviews on topics that were not of significant interest to me. What this has re-enforced for me is what I would describe as a disconnect between academia and the

day-to-day lived experience of technology education teachers. While academic research may be informing what happens in many classes, it seems to offer little to those teaching in hands-on classes. I can only imagine how different this programme would be for me if I were able to study material that I thought was significant and relevant to my day-to-day working and teaching experience. I felt the same disconnect for much of the year spent at UBC completing my year of pedagogical studies, and my experience with this course has only reinforced that belief.

An ex-student of mine, made a comment that I think is as useful as any of the information I gleaned from the research of current literature, which was, “Teachers are good for one of two reasons, they have big personalities, or in depth subject knowledge”. I didn’t find as succinct a statement in any of the research articles I read about student motivation and engagement, but as practising teachers, most of us can nod in agreement with this student’s statement. I suspect the clues to creating projects that engage students in your own class will likely not be found in academic articles, but from practical experiences as a classroom teacher, conversations with experienced colleagues and knowing your own students. What motivates one student may not motivate another.

**Key recommendation for other educators interested in engaging in topic.**

One of the main issues I have had while working on my master’s project addressing student motivation and engagement and how it relates to technology education and project design is the lack of research that I was able find. The first thing I would suggest to a colleague who is interested in engaging with this project topic is to seriously consider doing primary research. It was suggested early on in our coursework that performing primary research was not necessary, and would require the necessary steps to

receiving approval from the university ethics board. Given the lack of research I was able to find with regard to technology education, I think the efforts made to conduct primary research would be well worth it. It seems ironic given the exposure trades training and the anticipated shortfall of skilled trades' people in the future how little research there is with regard to technology education. It is my opinion that the logical place to interest youth in hands-on trades is in high school shop programs, yet there seems to be little research to either support or refute this.

As a strong supporter and advocate of hands-on learning, I know the skills and personal development gained from learning in shop class is valuable and important for our children. While there is currently a lack of research that pertains to technology education, this master's project and literature review makes a small contribution that can help to address the gap that exists in this area. Projects such as this one and subsequent work by others interested in furthering their knowledge in technology education can only serve to enrich and expand the current knowledge base.

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