# System Dynamics in the Traditional Humanities Survey: Engendering Perceptions of Relevance in a Field Under Threat Through Use of System Dynamics

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## ABSTRACT

Most American colleges and universities have humanities programs and humanities general education requirements, and most of these programs have gradually dwindling enrollments. In public discourse, the term "crisis" is often used to describe this overall situation. This poster describes a curriculum I designed for the Maine Maritime Academy that uses basic system dynamic modeling (primarily CLDs, BOTGs and stock and flow diagrams) to increase perceptions of relevance for this core curriculum and offers a proposal for much larger scale implementation of the concept for multiple institutions.

**Basic conclusions:** SD is an ideal medium for revitalizing this common general education requirement. To optimize the curriculum would require a team of experts to help create of historical case studies and relevant data sets to enable entry-level modelers to create useful scalable models.

**Goal:** To generate interest amongst system dynamicists who might be interested in participating the creation of these case studies.

## Introduction

For the past eleven years, I have been a Professor of Humanities and Communications at the Maine Maritime Academy, where my main role has been teaching a very traditional two course humanities sequence, the goal of which is to introduce students to the cultural roots of our current world system. The two courses are divided along traditional chronological markers: Humanities I covers the time frame from the beginning to the renaissance, and Humanities II covers the period between the renaissance and today.

Typically students resent these classes because they believe them to be irrelevant to their major fields and to any real career outcome**.** Students at Maine Maritime Academy enroll in a variety of majors housed in four core departments: Engineering, Management, Marine Sciences and Transportation. This limited number of majors gives us a different demographic than most colleges, but the essential problem of perceived irrelevance plagues humanities curricula at most schools.

System dynamics has proven to be highly effective in solving this problem because the basic concepts of stocks and flows, feedback loops, system archetypes, etc. easily tie into traditional teaching models that try to show, through narrative, how social systems operate. Further, professional SD modeling software packages (for example, Stella Pro or Vensim) have relatively inexpensive or free versions students can easily afford, and they also have relatively easy learning curves for the basic structures. Most importantly, the basic principles of SD are applicable to virtually all of the majors at my school and to virtually all of perceived high wage majors at any school, so I can claim direct relevance

of the training to many careers.

The purpose of this paper is first to describe the structure of the curriculum and its use of system dynamics, then to propose means by which the curriculum can be conveniently exported so that it can be effectively used as part of similar curricula at other schools where system dynamics may be unknown. Finally, some results of student work will be shown to illustrate the basic processes and their usefulness. One of the benefits of this approach (especially given the fact that system dynamics is virtually unknown in the historical professions) is that even introductory student work can be cutting edge.

The typical humanities curriculum can usefully be divided into two areas, the first of which is a set of core competencies that tend to have rough similarities across schools: here is one such list from Worcester Polytechnic:

- Introduces students to the breadth, diversity, and creativity of human experience as expressed in the humanities and arts.
- Develops students' ability to think critically and independently about the world.
- Enhances students' ability to communicate effectively with others in a spirit of openness and cooperation.
- Enriches students' understanding of themselves.
- Deepens students' ability to apply concepts and skills in a focused thematic area through sustained critical inquiry.
- Encourages students to reflect on their responsibilities to others in local, national, and global communities.
- Kindles in students a lifelong interest in the humanities and arts.

Along with this general set of goals, there is the necessary information content. In the (typical) humanities core sequence at my institution, many fields are included in this set of information:

- history
- art history
- anthropology
- music history
- sociology
- literature, etc.
- In fact there is so much required information (it can easily become the sum of all human experience), that it can be difficult to avoid the temptation of simply summarizing important bytes and quizzing students on the facts alone. There is always a complex dance being played out between summary and depth.

Hence, we have moved past the simpler days when the basic humanities requirements were met with a simple Western Civilizations class, and humanities faculty in general struggle with the question of how to organize the information so that it can really articulate the web of interconnections that makes the world itself so complex.

**The role of system dynamics in this kind of curriculum**

One of the chief benefits of system dynamics for this purpose is its deep emphasis on the interconnected nature of all elements of systems. To use an art metaphor, it emphasizes the negative space over the positive space, the interconnection over the individual. Because of this emphasis on interconnectivity, which is usefully made visually clear in software packages like Stella Pro or Vensim, system dynamics concepts help the humanities instructor go beyond the traditional historical method and more effectively discuss and demonstrate the long term complex effects of socio-evolutionary processes and the underlying evolutionary structures that drive civilizations while offering students useful skills for their careers.

For example, in my Humanities I class, students study the beginnings of the renaissance in the disaster of the Black Death, which hit Europe hard and with devastating recurrence in the 1300s.

In the traditional humanities course, this data is delivered through a narrative re-telling along with primary information (material from the time period) that is used as illustration. To illustrate the Black Death as representative of common patterns, we might discuss it as a recurring theme (the fear of plague, for example) that might lead to certain kinds of societal outcomes (for example, fear of the apocalypse), and then we would leave it behind, moving on to the next data in the chronology. I could give many examples of this handling of data, but note that there is a similar pattern: one discusses the situation, then one hypothesizes linear, historio-cultural cause effect patterns, and then one moves on.

If one is working from either an anthropological or sociological perspective, one might begin to move past simple cause and effect and start to work with statistics to look for more scientific patterning. For example, sociologists have extremely useful understandings of commonalities amongst evolutionary stages in the social life of humans (commonly listed as Hunter-Gatherer, Horticultural, Agrarian, Industrial and Post-Industrial). These include a set of forces (Production, Population, Regulation, Distribution and Reproduction) and a set of evolving institutional systems that these forces produce (economy, kinship, religion, polity, law and education). These hypothetical structures are very useful beginning points for understanding the patterns of human social evolution over time.

In either of these traditional approaches, it is always difficult to show how these forces and structures actually function, so that we can move past narrative retellings of the past (which always hold within them the narrator's own bounded rationality) and allow the structural elements of past conditions to come to the fore, so that we can identify recurring patterns of past behavior with exactitude.

That's where system dynamics comes in.

SD stock/flow and CLD structures in their most basic form revolutionize the non-linear elements of the teaching. For example, in teaching the Black Death, one can look at the historical record and begin to ask who and what is involved in the

processes by which the plague began. Using SD one immediately sees multiple causes and multiple effects, and, as one begins to answer those questions, items useful for modeling immediately begin to appear. One knows there are rats involved, and one asks where they came from? One knows there are ships and sailors involved, and one asks where they came from. Quite quickly the class conversation moves from the fact that the Black Death happened to the question of how it came to be in dynamic, nonlinear terms.

This move from one question type to another, from what happened to what structures allowed it to arise, transforms the course and its perceived relevance. Once we start to model the question of how it happened, we easily move to the question "how do we prevent recurrence?," and we are in the problem solving mode relevant to virtually all high-pay majors in a typical school. This is a transformative transition in the learning process.

If one were to get to that "how?" question in the non SD version of this class, one would usually stop with another narrative explanation (almost always coupled with a simplistic cause and effect bias), but with SD modeling in mind, that's never quite enough. Instead students quickly grasp the fact that there is no simple narrative explanation, that narrative, by its over-emphasis on linearity, tends to generate simple cause and effect responses that neglect the underlying complex structure of the interconnecting pieces.

This recognition comes from the simple process of breaking the situation down into its component parts and asking how the stocks and flows interact to create the overall structure. Questions like the scale of the problem quickly come up as students begin working with the flow arrows and wondering what fills the cloud.

For example, in working with the Black Death, one naturally starts with the rats that carried the fleas that carried the bacillus. One realizes that in this small relationship there is a system that can be modeled, and one student takes on that small piece as a research project, gathering the information available and beginning to develop stock/flow and causal loop hypotheses that inform this small piece of the puzzle. Obviously we all know that's not the only part, so our whole conversation becomes about the interconnections between scales in the problem we're reviewing. Another student then works on the relationship between the rats and the ships, and another series of stocks and flows begins to emerge from the problem. We can parse the historical situation into literally dozens of these smaller modeling scenarios, usefully pushing the idea of relevance of parts of the whole. Do we really need to know, for example, about ideas of treatment and the history of medicine of the time? Naturally yes, we answer, because that informs the way the victims were handled, so another modeler takes on another small piece of the puzzle. As we work our way through the many pieces of the puzzle, the enormity of the fact of the plague gradually settles over the group in a way the non-SD version of the course never quite reaches. Further, each iteration of the course can build on these already completed models, extending the larger structure of the problem and deepening our collective understanding.

In the final analysis, these modeling experiences then let the problem of the Black Death of the 1300s become an exemplar of models of disease transmission in later (or earlier) times, and the SD concept of an archetypal or generic pattern begins to make real sense to students in historical terms.

At this point in my development of this curriculum we have done collective modeling of this type on three different historical cases: the Black Death, the Battle of Agincourt and the rise of the Medici as patrons of the renaissance, and in each case, I believe we are making new steps forward in revealing the underlying structures of the time (testing this conclusion is part of my purpose here, and I hope you all agree with me). I'll walk you through some of our results at the end of the presentation.

One of the best things about this curriculum is that it is quite easy to add to an already established program. All I use to teach the SD portions of the class is Donella Meadows's Systems Primer, which has the benefit of being quite short and wonderfully clear. Even a neophyte instructor could facilitate useful work with stock and flow dynamics from this book with minimal further training.

**Summary of Benefits of SD Approach in Traditional Learning Outcomes**

This SD approach yields significant benefits over traditional models of humanities surveys on many levels. Going back to the list of outcomes from WPI, I'll add these perceived benefits in italics:

- Introduces students to the breadth, diversity, and creativity of human experience as expressed in the humanities and arts. *SD allows students to see the social structures out of which these creative expressions emerge in much more (and more rigorous) detail by emphasizing the web of interconnection out of which they arise.*
- Develops students' ability to think critically and independently about the world. *The SD approach, because it forces us to critically model historical structures, introduces students to a level of logical detail and organization that is often entirely new to them. By the end of the course, they state quite openly that they are seeing system interconnections everywhere.*
- Enhances students' ability to communicate effectively with others in a spirit of openness and cooperation. *The graphical logic of the SD modeling approach helps people see their logical connections on the page in a really new way. Students become more attuned to webs of interconnection and learn to speak of them in a much clearer way than before.*
- Deepens students' ability to apply concepts and skills in a focused thematic area through sustained critical inquiry. *The SD modeling approach sustains deep critical inquiry (the modeling forces this) and adds the concept of scale of model parameters, an element usually absent from normal humanities courses.*
- Encourages students to reflect on their responsibilities to others in local, national, and global communities. *The SD emphasis on the interconnection of parts as the main element of systems helps people develop a strong sense of their own place in a network of beings. Watching the historical panoply unfold*

*shows them the place of their current generation in the larger field of human history.*

- Kindles in students a lifelong interest in the humanities and arts. *Students often report a surprising (to themselves) level of interest in the concepts and ideas underlying the class and also report that the use of systems theory changes the way they think about the world in extremely useful ways.*

**Thoughts on Moving the Curriculum Forward**

I believe the use of system dynamics in the study of the humanities could quite literally transform the humanistic paradigm if it is allowed to grow and evolve.

Given the paucity of historical models available, under properly trained instructors even introductory students, at this point in the game, have the chance, given proper resources, of producing publishable work. This allows even introductory students the chance to participate in the production of scientific knowledge (with publication credit), at a very early stage in their careers. This has the benefit of really motivating them to produce excellent work, and it is a radical transformation of the knowledge creation process typical of introductory humanities instruction.

In dreaming of this future SD humanities curriculum, I see the following:

- Historical modeling and pattern understanding that leads to infinitely more detailed evolutionary models of culture.
- A joining of history, sociology and anthropology as facets of the overall modeling of the human experience through time. Each has pieces of the theoretical puzzle to offer, and the modeling process is what is likely to bring them together.
- Development of historical pattern archetypes

**Necessary next steps**:

In order to properly model historical situations, one needs access to information from a number of different disciplines: history (which holds the linear narrative together through work on a variety of different media), sociology (which works to describe the structures and evolution of culture), anthropology (which also deals with culture but from a different perspective and includes human physiology), historical ecology (which studies the relationships between humans and their environment), art and music history (which usefully focus on subsets of the historical overview), and other fields that deal with the earth itself through time.

In order to facilitate this collaboration, I propose building a team of researchers to create a set of case study data sets for humanities modeling. These researchers would come from the above fields, along with system dynamics, and would agree on a few central cases to develop. Then they would meet together to explore the way research could be gathered and structured to make it possible for students to usefully create fundamental models for humanities research.

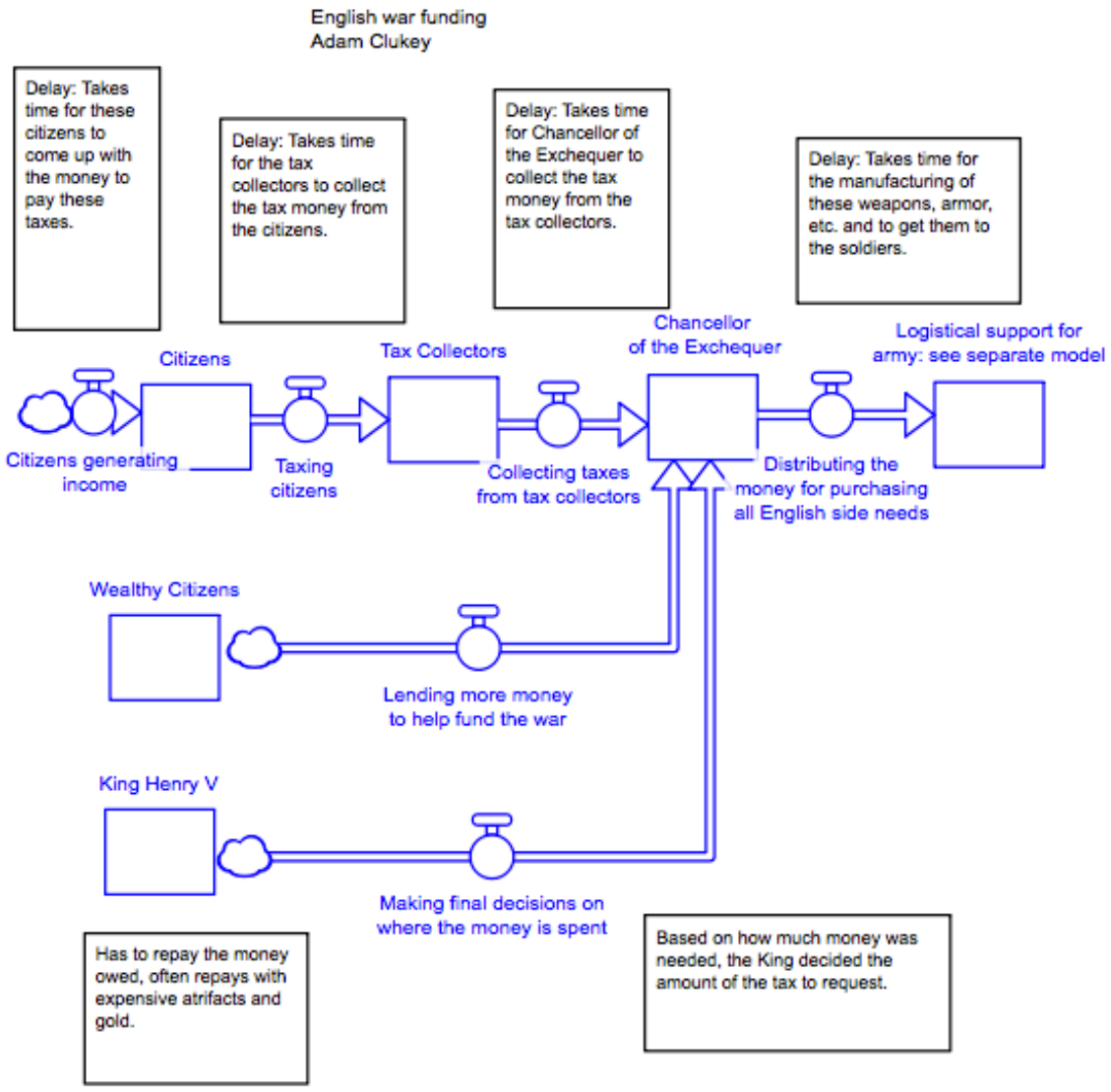
**Note:** this case studies material would be primarily data sets and primary source

material, not pre-created cases such as the those available from the Creative Learning Exchange.

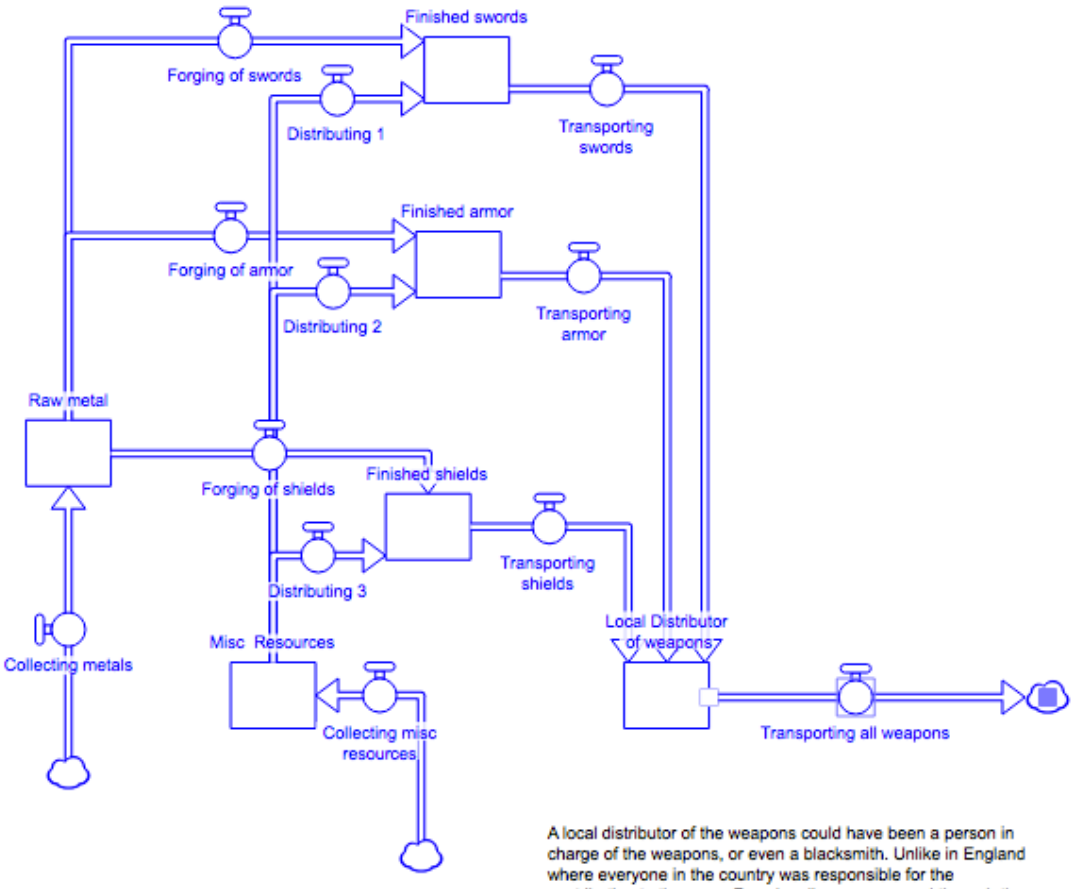
**Preliminary Case**

The following models illustrate the concept I'm developing. Each is the work of one student tackling a tiny portion of a larger project. These are *very* preliminary, but they show how introductory student work can actually show structural connections in well-known and deeply studied historical cases. Each represents a section of a much larger group model (with over forty models and short technical papers) of the battle of Agincourt in 1415 and could become a full simulation if the case study data sets discussed above were available to the students for their modeling purposes. These models have not been edited to a peer-review standard and represent the student work as turned in to me. The next phase of the project is to develop them further, correcting them and editing the group project into a deeper more cohesive whole.

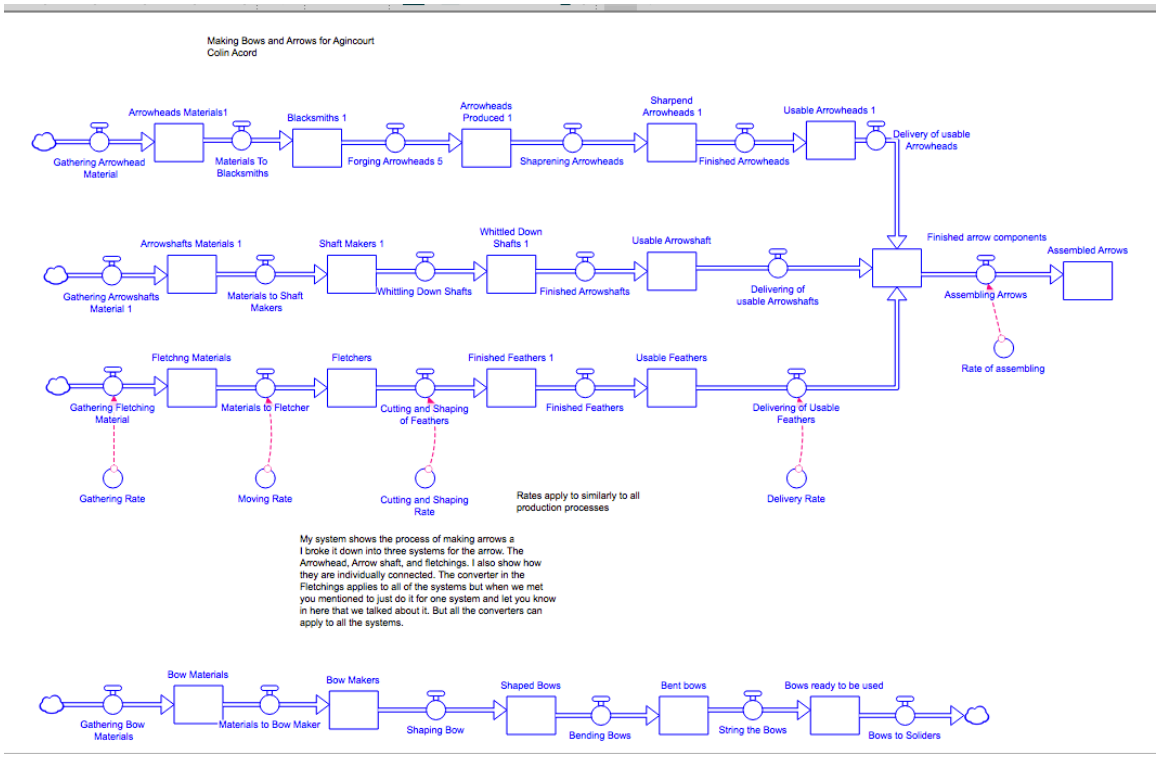
**Note:** the simplicity of the simple stock and flow models that follow reveals errors in student logic in a way that I have found uniquely useful for basic logical training. The basic models that follow connect to each other to create larger structures defined by the researcher at the helm of the class. Further they could be turned into simulations by further researchers with greater modeling knowledge in advanced classes. This means that at every level of sophistication from most basic to most advanced, the SD approach demonstrably improves the teaching.


English war funding
Adam Clukey
Delay: Takes time for these citizens to come up with the money to pay these taxes.
Delay: Takes time for the tax collectors to collect the tax money from the citizens.
Delay: Takes time for Chancellor of the Exchequer to collect the tax money from the tax collectors.
Delay: Takes time for the manufacturing of these weapons, armor, etc. and to get them to the soldiers.
Citizens
Tax Collectors
Chancellor of the Exchequer
Logistical support for army: see separate model
Citizens generating income
Taxing citizens
Collecting taxes from tax collectors
Distributing the money for purchasing all English side needs
Wealthy Citizens
Lending more money to help fund the war
King Henry V
Making final decisions on where the money is spent
Has to repay the money owed, often repays with expensive atrifacts and gold.
Based on how much money was needed, the King decided the amount of the tax to request.

Tanner Littlefield
French Weapons Model




A local distributor of the weapons could have been a person in charge of the weapons, or even a blacksmith. Unlike in England where everyone in the country was responsible for the contribution to the army, French soliers were armed through the local dukes and communities.


Making Bows and Arrows for Agincourt
Colin Acord
Arrowheads Materials1
Blacksmiths 1
Arrowheads Produced 1
Sharpend Arrowheads 1
Usable Arrowheads 1
Gathering Arrowhead Material
Materials To Blacksmiths
Forging Arrowheads 5
Shaprening Arrowheads
Finished Arrowheads
Delivery of usable Arrowheads
Arrowshafts Materials 1
Shaft Makers 1
Whittled Down Shafts 1
Usable Arrowshaft
Finished arrow components
Assembled Arrows
Gathering Arrowshafts Material 1
Materials to Shaft Makers
Whittling Down Shafts
Finished Arrowshafts
Delivering of usable Arrowshafts
Assembling Arrows
Rate of assembling
Fletchng Materials
Fletchers
Finished Feathers 1
Usable Feathers
Gathering Fletching Material
Materials to Fletcher
Cutting and Shaping of Feathers
Finished Feathers
Delivering of Usable Feathers
Gathering Rate
Moving Rate
Cutting and Shaping Rate
Rates apply to similarly to all production processes
Delivery Rate
My system shows the process of making arrows a I broke it down into three systems for the arrow. The Arrowhead, Arrow shaft, and fletchings. I also show how they are individually connected. The converter in the Fletchings applies to all of the systems but when we met you mentioned to just do it for one system and let you know in here that we talked about it. But all the converters can apply to all the systems.
Bow Materials
Bow Makers
Shaped Bows
Bent bows
Bows ready to be used
Gathering Bow Materials
Materials to Bow Maker
Shaping Bow
Bending Bows
String the Bows
Bows to Soliders