Machine Dossiers

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> Dossier, noun. "A file containing detailed records of a particular person or subject."
> - Merriam-Webster Dictionary[2]

Synopsis: This is an investigation and a specification of the materials which must be created by a researcher to describe a potentially complex historical machine. It concentrates not on the items intended for formal public presentation but rather on the more extensive but less polished material which must be generated in order to form a complete record of the machine. This potentially large collection of material, which is intended for internal use but which is an open research environment should be made freely available to the public, constitutes a "dossier" on the machine in question.

1 - Preface

Every important machine (or closely related set of machines) in a collection needs a set of documents or other media[3] which describe it as completely as possible. The machine could be anything from a pocket watch to a steam locomotive.[4] As envisioned here, typically it will be an older machine for which little or no documentation exists.

Each user of this documentation will have their own needs and perspectives. Thus, the uses that a machine dossier will be put to by a practical operator will differ from those of a museum curator. The machine rigger will have their own needs when moving it; the machinist will have different needs when making a new part for it. There is no single audience and addressing all audiences is probably impossible. Still, when creating a machine dossier it might be wise to keep in the back of your mind a sort of worst-case audience: consider always someone hundreds of years in the future, long after all of the physical artifacts have been destroyed, who wants to recreate this machine exactly as it was in its era of operation. Help them to do this.

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1 Revision 4d, 2023-02-28. (dmm@Lemur.com, www.CircuitousRoot.com). This is both very much a draft (in terms of content) and also an interim version pending the conversion of this document into one marked up in LaTeX. The current distribution of this document is at: https://www.CircuitousRoot.com/artifice/past-future/index.html

2 Merriam-Webster Dictionary. https://merriam-webster.com/dictionary/dossier Accessed 2022-12-19.
3 That is, not just text documents, but possibly also collections of photographs, CAD models, spreadsheets, video clips, voice recordings, etc.
4 The two machines which I'm working on as I write this, and which are serving as test cases, are a Benton vertical pantograph (typographical engraving machine) and a Barth type casting machine (both formerly in operation at American Type Founders Company).

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3 - What this is Not

You may have stumbled across this document on the Internet and might think that it is just the thing for your project. There is a good chance, though, that it isn't.

3.1 - Not for Accredited Museums

If you are responsible for machines in the collection of a museum which has or seeks accreditation, please do not use this document or its approach. It will not fit with the needs of those in charge of your institution. Further, the author has no institutional affiliation and no official qualifications.

3.2 - Not About Conservation Practices

The information in a machine dossier begins as record of what is. It will be (or should be) used to guide whatever it is that you do to the machine: cleaning, conservation, restorative conservation, etc.[5]

The first portions of a machine dossier should guide any such actions. Later portions should document them.

However, this present document about what is in a machine dossier is not itself a guide to conservation or any other modification[6] of a machine.

3.3 - Not a TDP

In the early 21st century in the USA there is a concept in government and business of a "Technical Data Package." A TDP seeks to encapsulate in documents all of the knowledge required to manufacture a product. There is a significant overlap between this and machine dossiers, but they aren't the same thing.

A machine dossier includes information regarding curation and conservation which is not a part of new product manufacturing (and thus not in a TDP). Much of the approach here will not be useful to you if you're creating a TDP.

Further, while there is much that is good in TDPs, the concept of a TDP is a part of the lucrative world of supplying military contracts. As a result there has arisen an industry sector devoted to selling to companies "solutions" for meeting military contract requirements. This amounts to selling software for ticking off checkboxes. For the creator of a machine dossier, this is a problem because it creates a huge quantity of noise which obscures serious inquiry into the transmission of technical data.

If you are in the business of meeting formally required TDP specifications, this present document is not for you. Please go elsewhere; this will only confuse your work and will lead you to losing the contract.

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5 "Restoration, " so called, is really a form of well-intentioned vandalism.
6 Or choice not to make a modification.

4 - How Much, How Little, What Else, How Perfect?

A machine dossier as described here can contain many elements. As such it can seem overwhelming at first. It is important to realize, however, that these are just possibilities. Every machine and every machine's situation is different. Every machine dossier will reflect this.

At a very minimum, the first three items in the outline of a dossier are probably always necessary: (i) an identifier (identification code) for the machine, (ii) a brief description of the machine with some indication of its importance, and (iii) a photograph of it. Everyone needs these: a museum curator, your insurance company, the online content creator who wants to make a video about it, your heirs as they figure out how to settle your estate, ...

The maximum level of detail envisioned here, on the other hand, is something that is probably rarely necessary and almost never has been achieved: enough re-engineering to put you in a position where you could begin to manufacture the machine again.

Between these extremes, do as little or as much as the situation requires and your resources allow.

You may also find that your machine requires something in its dossier which isn't envisioned here. Just add it. Every machine is different.

A machine dossier is not a "public" document in the sense described in the next section. It's more like a notebook. It doesn't have to look good. It can contain hasty, unpolished writing. It will have mistakes. Mistakes of fact should be corrected, but "mistakes" of style can stay just as they are. It is an informal document. It won't ever manage to have everything, so don't wait until you have everything to write it. It can contain gaps, "this is not finished" notes, and "to do" notes to yourself. This is not to say that you should make it deliberately bad, but don't get hung up on making it look good. The perfect is the enemy of the done.

5 - Public vs. “Internal” Documents

For a machine of historical importance, there are two general categories of documents.

One category consists of documents intended for the public, broadly considered.[7] These documents might include:

- Publicity material, generally considered, including:
  - Simple museum-style identification placards.
  - Short “press releases” which might be useful to journalists, online “content creators,” *et al.*
  - Short films or video presentations.
  - Snippet-level content for social media.
- “Semi-technical” historical and technical accounts of (for the well-educated non-specialist).
- Scholarly studies of the machine and/or its context.
- Specialized assessments (to secure funding, to satisfy health & safety regulators, etc.).
- Moving (rigging) documents.
- Installation (millwright’s) documents.
- Practical instruction manuals for operators.
- Practical maintenance and repair manuals.
- Engineering drawings, including detailed part manufacturing drawings.

The unifying feature of all of these diverse public documents is that they require a relatively high degree of polish. You are this machine’s advocate. You speak for it. You want it to look good.

But tempting as it might be to sit down a a machine and to start to make a public document, doing so it probably a bad approach. All of these public documents require a great deal of groundwork which must already have been done: detailed notes, measurements, records, historical research, technical drawings, photographs, the rough draft of the operator’s manual which the original manufacturer never wrote,[8] etc. The sum of all of this groundwork is what I’m calling here a “machine dossier.”

7 The “public” may of course consist of casual museum-goers on family vacations, of course. More importantly, it may consist of potentially very well informed people with a strong interest in the subject area who are not specialists in this particular machine. An example member of the public for a Benton Engraving Machine might be an expert in digital lettering design. Public documents must address all levels of background. You are looking for people to help you save this machine; you never know where you’ll find your best friends.

8 Because if you cannot operate the machine you *will* make mistakes in describing it. This is one of the most important lessons that I’ve learned in over three decades of technical writing.

6 - Public Visibility and Tool Requirements

6.1 - Dossier Publication and Licensing

Just because the documents in a machine dossier are not "public" (in the sense discussed above) doesn't mean that they should be secret. To the contrary, the best way to approach any such project is with full transparency. It is not easy to work in the open; people keep interrupting you and you will always be the subject of strong opinions about what you're doing wrong.[9] This is hard, but it is good: the people who are interrupting you are at least interested in your obscure obsession and those who are telling you how wrong you are may (sometimes) even say something you can learn from.

So a machine dossier should be published as it is written. This is easy to do on the Internet. It probably shouldn't go on the home page of your website, but it should be easily findable by enthusiasts.

A corollary to this and to the need for long-term survival of the dossier is that it must be licensed in a freely copyable form.[10] This means that text and computer code must be licensed, explicitly, under any of several open licenses. At a minimum, non-program documents must be licensed under any of the Creative Commons licenses which do permit derivatives.[11] Programs (if present) must be licensed under at least the Free Software Foundation's GNU Lesser General Public License.[12]

When I talk to people about old machinery, they usually can handle surprising levels of intricate detail. But there are two subjects where I can watch people's eyes glaze over as they deliberately turn their brains off: three-phase power and copyright/licensing. I admit that intellectual property issues are not particularly interesting to those who aren't lawyers, but that doesn't mean that they are incomprehensible. If you're reading this document, then the chances are that you can operate dangerous machinery of stunning complexity. Intellectual property is much simpler, because it's all just the working-out of greed in the world of ideas. It isn't that hard. You can do this. To save these machines you *must* do this.

6.2 - Restrictions on Reproduction

A machine dossier should include (when they exist) documents from the history of the machine: bills of sale and receipts to establish provenance, original advertising material, original manuals, original engineering drawings (if you're lucky enough to have them!), films of its operation, audio interviews with operators, and so forth. Whenever possible, these documents/media should be included as digital files in the machine dossier.

9 The chances that you will convince your critics that you are correct is vanishingly small.

10 Copyright today is constructed for the benefit of holders of large media portfolios. Its period extends beyond the span of the survivability of media (both print and digital). Scholarly publication is just collateral damage. Unfortunately the understanding that most people have of copyright, licensing,and intellectual property issues is almost always entirely wrong. This combination results in a problem. The literature of my field (type machinery) is littered with examples of reprints of rare items which have been reprinted without explicit open licensing. Those reprinting them are convinced that they are "saving" these items, but in fact they are destroying them. All copies will have been lost before their new copyright has expired.

11 The CC-BY (Attribution) is the most open and the best. CC-BY-SA (Attribution, Share-Alike) is the "copyleft" version and also appropriate. The "-NC" (NonCommercial) versions are probably ok, but this is an unnecessary limitation as nobody is going to make any money from this anyway. The "-ND" (No Derivatives) versions are not ok, since they lock down your material and do not permit others to use it (this is antithetical to good scholarship).

12 This is the non-copyleft version of the GNU General Public License (GPL). Either is fine; this issue of which is preferable (GPL or LGPL) is a matter for discussion. The more permissive MIT License is fine, too.

But there may be restrictions on what you can reproduce or share. Documents may be in copyright and you may not have the right to reproduce them. Contractual arrangements with sellers may give you access to certain documents but not the right to reproduce them. In jurisdictions where there are legal rights to privacy, you may not have the right to reproduce images of some individuals. I'm sure that other restrictions will emerge; it is a sad result of our society's obsession with intellectual property.

The solution when these situations arise is to create a secondary, private, archive of unreproducible material. Things in it may be referenced from the machine dossier, and if possible access to it might be granted to individuals (within whatever terms its restrictions might permit). But it would not be made generally available with the rest of the machine dossier.

6.3 - Dossier Creation Tools

It isn't enough that your documents and media are open source. Your tools must be, too. If you've ever had to extract and reconstruct data from a document which was done in some now-obsolete proprietary format, you'll understand this instantly (and it will bring back painful memories).

The tools must be free (no cost) so that anyone might take up or branch the project, even if they have very limited resources. (Assume that they own a computer, but nothing more.) The tools must be open source (and, best, freely licensed in at least the GNU Lesser GPL or MIT License senses) so that in the future when the current tools are dead and gone someone then might take this project's materials and build new tools which can still use it. Don't lock up files in proprietary formats which will be abandoned and become unreadable. Consider also the platform you are using. An open platform such as Linux is your friend. Closed platforms (from Apple, Microsoft, and Google) are problematic. If your tools cannot run on at least two platforms now, they're not going to run on anyone's platform a century from now.

There is a problem here for CAD, because at the present point in time there are no open source CAD solutions sufficient for the 3D models needed in a full machine dossier. There are no-cost ("free as in free lunch") solutions using commercial CAD programs (such as Fusion 360 or Onshape), but these have two issues: their free versions may disappear at any time (and will have disappeared in the future when these products have been terminated) and the internal formats of their models are all proprietary.

This means, unfortunately, that at the present time any work you do in 3D modeling for a machine dossier will necessarily be partially lost in the future. As careful as you may be to output STEP files and produce 2D drawings from your models, in the future all of your work creating the underlying CAD design tree/history will be lost.

See the "List of Tools and File Formats" later in this document for lists of tools which are (and are not) appropriate.

7 - Attribution and Responsibility

It is important to know who did what when. Each entry into a machine dossier (each picture, each text description, each CAD model, etc.) and each revision of each entry should be identified with the name (or initials, or some code) of the person responsible and the date. The format for this can be anything that works.

8 - Limitations and Iterations

People have been trying to document machines since antiquity (in both the west and east). It is very, very hard. Take a look at the drawings of Villard de Honnecourt (13th century) or Joseph Moxon (17th) to see just how hard it is. They were excellent observers but were inventing the field as they went along. It can now be very difficult to understand them. Again, good technical writing is very hard.

Even in the 20th century, when things which might now be called Technical Data Packages existed, it was hard to capture everything. I have a friend whose father worked for a manufacturer behind the old Iron Curtain. The state industry he worked for had licensed the production of a complex product from a very large company in a major western industrial nation.[13] They had received all of the official technical documentation for this product but still were unable to manufacture it because much of the information "contained in" the product was actually oral history passed down within the families who owned the hundreds of small companies which supplied parts and assemblies to the western company. It was my friend's father's job to travel to all of these small companies and to extract from them, as best he could, this orally transmitted knowledge. Paleolithic societies were built on oral histories. Modern industry is still built on oral history - we just call it "institutional knowledge."

You won't get it right the first time, or the second, or third, or... All it can be is the best that you can make it now.

13 I am anonymizing things here because I do not have permission to tell this story with names.

9 - Discussions, Division I (Identification)

The first set of documents are all generally involved in identifying the machine from both a historical and a technical perspective. Depending upon the complexity of the machine and relative availability of information, it might be possible to combine them into a single file.

9.1 - Overview

9.1.1 - Identification Code

Every machine needs some unique identifier. This could be an accession number or some other character value.[14] So for example the Benton engraving machine (second model) in the CircuitousRoot collection has no confirmed serial number but the parts of its pantograph arm have been match-marked "53" (and there is a good chance that this might have been a serial number). It is also a Benton pantograph of the kind that I'm calling "Type 2a." So, perhaps rather arbitrarily, I'll identify it as "BEM2a-53".

9.1.2 - Brief Description and Summary of Importance

In words describe as briefly as reasonable what the machine is, what it did, where and for whom it was used, and why this is important. Think here in terms of a well-written museum placard or the first paragraph of an encyclopedia entry.

9.1.3 - Basic Identification Photo(s)

It is best if there can be a single good photograph of the machine which gives a real sense of what it is. This is the picture that you might put on the cover of a public document or supply to someone writing something for the press or social media. Give people *one* picture which shows what it is, because that's all they're going to use.

If necessary to show the machine completely, there might be a very short set of photos from different angles.

9.1.4 - What Does It Do?

In more words than the brief description above, describe what this machine did and how it did it. The emphasis here is technical, not historical. Illustrations might help. (It may be useful to revise these later, after 3-D CAD models are developed and 3-D illustrations can be derived from them.)

14 The characters used need not be limited to ASCII, but should be in Unicode so that they can be used by computers. So if I were fortunate enough to acquire a Hakko type casting machine (which in later models was the most sophisticated single-type casting machine ever made), the name "Hakko" in Japanese (八光) or Hakko Type [caster] (八光活字) should probably be a part of its identifying code.

9.1.5 - What Was Its Historical Context?

When, where, why, and for whom? We generally think of cultural and social-historical context here. Think also of where this machine fits in the development both of related machines and the development of technology generally. Photographs of all kinds may help here.[15]

9.1.6 - How Rare Is It?

Resources are finite. Anything you do to help one machine takes time, money, etc. away from another. An important factor (though not the only factor) in allocating resources is knowing how rare a machine is.

This requires a census of similar machines, which is not always available (or reliable). So typically this is a best-guess effort.[16]

For the Benton pantograph BEM2a-53, this section developed into a standalone document.

9.2 - Provenance

Who actually manufactured it? When? Where? Where was it first used? What was its path of ownership from then to now? This is a good place to record the details of your acquisition of this machine.

In each case, how do we know this? Here is an instance in which the machine dossier may start to include reproductions of documents from the history of the machine (such as bills of sale or correspondence with previous owners). But there may be issues of copyright and privacy surrounding these documents.

It may be interesting to have a collection of photographs (and texts? video?) of your acquisition of the machine. Rigging trips can be eventful and make interesting stories.

9.3 - General Photographic Survey

Once the machine is safely in the shop and in place, it is good to take a set of reference photos with a proper camera in good lighting conditions. These should contain both overall and, as relevant, detail shots. It should be much more detailed than the "basic identification photos."

Do not be too hasty about cycling the machine. This is tempting, but it is very easy to break things in your current state of knowledge. Some machines are large and spring-loaded (such as Linotypes);

15 It remains important to pay attention to issues of copyright, license, and other limitations to the right of reproduction. Only photos which can be freely reproduced will be useful here.

16 Note also that even when it exists a census cannot be used uncritically. So for example in a rough census of type casting machinery the most common surviving machine is clearly the Thompson Type Caster - in absolute numbers. But the most common in terms of percentage of machines produced which survive is the Barth - fewer machines survive, but they are a much greater fraction of the total number produced. The machine which has the highest percentage of surviving machines in working condition is the Super Caster, because in the West typically it was the last and best machine in service in any given situation. Conversely, while the pivotal type caster has the longest record in production (1840s through early 2000s) and was produced in great numbers, it is one of the scarcest of major machine types today because in the late 20th century pivotals were older machines which tended to be scrapped. Note also that census information carries cultural and linguistic bias. So my census figures for the USA are much more accurate than they are for other areas. A census is important, but in evaluating a machine for its dossier you need to understand what the census is telling you.

you can hurt yourself as well as the machine. Perhaps it is best to save the videos of the machine in motion for later.

9.4 - Record of All Markings, Tags, Etc.

Be thorough and include everything: maker's nameplates, serial numbers, inventory tags, motor identification plates, dates. Each machine is different. It may be useful to include places where the paint/finish makes it clear that a tag has been removed.

Exception 1. Many cast iron components will have identification numbers cast into them. These numbers were for the use of the foundry and do not necessarily represent part numbers. At this stage they aren't yet relevant and they need not be included in the Record of Markings.

Exception 2. Do not include the operating markings on the machine (e.g., dials, calibrations along scales, etc.)

9.5 - Critical Issues in Conservation and/or Use

These are things we need to know now, before going any further.

9.5.1 - General Survey of Condition

This should be brief and should highlight problems.

9.5.2 - Missing Components

What isn't there is important for two reasons: it affects the value of the machine as a carrier of historical information, and it affects the difficulty of returning a machine to operational status.

Some consideration should be given to the scarcity of missing components. There is a range here. One extreme is that of missing components for which there is no surviving information.[17] Then there are missing components for which models exist (but which might or might not be available).[18] At the other end there are missing components which are generally available, at least at present.[19]

9.5.3 - Endangered Information

Is there any information which is in danger of being lost if we either do or do not do something regarding this machine. It is easy here to think of documents (preserving ephemera associated with the machine), but there are at least two other areas to consider:

Is there any oral history which might survive if we can manage to arrange an interview soon enough?

Are there physical features which might be lost if we do use/fix the machine? An example here would be the cutter geometry of the Benton vertical pantograph engraving machine. The BEM at

17 Example: The presumed setting blocks for a Wiebking/Ludlow pantograph engraving machine.
18 Example: The matrix holder for the Benton pantograph BEM2a-53 at CircuituosRoot.
19 Example: Linotype or Ludlow matrices.

CircuitousRoot came with three quills, one of which was an original ATF quill with a cutter which had been installed in it at ATF while they owned the machine. The only other two BEMs in operation presently are at Swamp Press and the Letter-kunde Press.[20] These have been equipped with cutters developed by Ed Rayher. These work extremely well and are practical, but they may not be of the same geometry that ATF used. The state of the cutters with the other surviving BEMs is unknown and at present not easily learned. So for the moment there is for me a single verified example of a known-ATF Benton cutter in existence. This is a case where a single object must be preserved statically. Sharpening it up to cut a mat would be a crime against the history of the machine. Make a copy of it to use.

9.5.4 - Potential Health and Safety Issues

These vary depending upon circumstances. The issues for a private collector will be less complex than those for an institution serving the general public. Still, a private collector needs to bear in mind that this machine will be operated at some point by someone who is enthusiastic but not well-informed. What would you write here so that years from now your grandchild remains safe at this machine?

20 Another Benton engraving machine using compatible quills, the "Ad-Cut" pantograph does survive. But its collection of cutters/quills is a part of the materials with the BEM at the Letter-kunde Press.

9.6 - Operating Context

Few machines are used in isolation. It would be a good idea at this point to expand upon the brief statements of operation and context in the “Overview” section earlier so as to explain the “ecosystem” for this machine. Describe more completely where the machine fit in to its immediate operating environment and where it fit in to the overall process of production of whatever product it was involved in. So for example (in my field) not only how a Ludlow Typograph relates to the Ludlow Supersurfacer and to printers’ saws, but also how hot metal typecasting and composing relate to a printing enterprise as a whole.

This should be just an orientational overview. For lists of specific related machines which might or might not be present, see the “Supporting Tools and Machinery” section in the Specifications, below.

9.7 - Specifications

9.7.1 - Capacities

Without reference to the details of tools and workholding, what size things can this machine work with? For a type caster, for example, what body sizes could it cast? If you were manufacturing this machine for sale, this is the statement that you would put into the first level of technical detail in a product brochure.

9.7.2 - Tools and Workholding

These are the specifications that an operator of the machine might be concerned with.

9.7.2.1 - Tool Holding (if present; e.g., collets)

If the machine holds some kind of cutting tool (or marking tool, or some other kind of tool), how does it hold it? (For example, what kind of collets do the two kinds of quills for the Benton Engraving Machine take?) What are the limitations on the kind and size of the tools?

9.7.2.2 - Work Holding

What kind of workpiece does the machine hold? (E.g., if it holds matrices, what style of matrices?) What are the limits on their sizes?

9.7.2.3 - Pattern Holding (if present)

If the machine holds a pattern (as a pantograph does), what are the physical limitations to its size? If known, what are the design limitations (the ratio of the pattern to the workpiece, for example).

9.7.3 - Overall Dimensions and Weight(s)

Overall width, depth, and height. You can either use metric units because that is what the world uses or you can use whatever units were native to the machine. Old printing industry machines in the USA were designed in inches and (sometimes) picas.

Don’t include the more complex measurements relevant to rigging here (e.g., minimum doorway it will fit through). Do those in the “Rigging and Moving Notes” section in Division III (Practice).

Don’t include detailed installation and millwrighting information (e.g., installation floor plans). Do those in the “Installation Requirements and Procedures” section in Division III (Practice).

Think in terms of a product brochure. What would go into the brief section which tells people how big it is?

9.7.4 - Inputs/Services

9.7.4.1 - Electrical Motors and Power Input

Include all motor ID plate data. Include all plug types (if present). Include heater and control ratings for casting machines. If possible, estimate the overall electrical requirements in terms of quantity (amps) and kind (voltage, phase).

This is also where you'll find out that someone years ago wired the machine with completely inappropriate and frighteningly unsafe wiring.[21] These things should be noted both in the "Potential Health and Safety Issues" section above and in the "Operating Experiments / Experiences" section in Division III (Practice).

9.7.4.2 - Mechanical Power Inputs

Include pulley dimensions and types. Estimate power needed.

You will often find inappropriate (but workable) belts fitted. It was common in the later periods of operation of many machines to run automotive v-belts where flat belts had been intended.

9.7.4.3 - Water/cooling Inputs and Drains

Include fitting types.

9.7.4.4 - Compressed Air Inputs

Include fitting types. To the extent that they can be determined, include required pressures (PSI in the US) and volumes (CFM in the US).

Indicate the purpose of the air. On a Barth caster it provides both cooling and swarf clearance. On a Monotype Keyboard it provides operating power.

9.7.5 - Lubricants Required and Lubrication Fittings

Start with a survey of the machine and good guesses. These should be updated as you gain experience.

It is well to understand what the various fittings actually are. For example, the fitting universally known today as a "zerk" is not a zerk (and was never so called by its maker, back in the day). A machine such as the Barth Type Caster may have both true zerks[22] and Alemite hydraulic fittings (what everyone thinks is a zerk).

NOTE: It is critically important that you understand that an Alemite hydraulic fitting (or compatible), which is what most people call a "zerk" today, ***is not necessarily a grease fitting***. It is a lubrication fitting which might be used with both oil or grease. In older machines it was more commonly used with oil than with grease. Each time you encounter one, you need to determine

21 As the saying goes, ask me how I know this...
22 Now rarely seen outside of certain sectors of the antique automobile collecting community.

whether it was intended for oil or for grease (or if it was installed decades after the machine was built into an oil fitting and then subsequently filled with grease by someone who thought that a "zerk" was always a grease fitting[23]).

If there are particular components of the machine which should not be lubricated (but might seem to require it), note them.

The lubrication of old machinery is a complex subject. There's a lot more to it than just "put 30 weight nondetergent on everything."

9.7.6 - Non-Attached Components

Not all parts of a machine are physically attached to it. The big examples of this in the field of type machinery are matrices and molds.

This is worth calling out as a special category for two reasons. First, these things frequently are overlooked when rescuing machinery. Second, they may cross machine boundaries. Matrices, in particular, may be used by several different kinds of typecasting machines. Where an how do you catalog/inventory and describe them?

Indicate here both what should be present with this machine and what you actually have.

9.7.7 - Supporting Tools and Machinery

List and if necessary further document hand tools used by the operator, even if common. (For example, if there was a screwdriver in the operating kit, as was the case with the Elrod stripcasting machine, note it even though it may have been a commercially available item.)[24]

Also identify specialized or less common tools used in maintenance. These may require more documentation.

Identify manufacturer-supplied operator tool kits (including tool boards) and maintenance tool kits.[25] Identify shop-made toolkits (e.g., printer's saw tool boards).

Identify also associated smaller machines (e.g., plunger cleaning machines for Linotypes). Note though that this probably should not include machines which are closely associated but which really are not direct supporting machines. So for example a pivotal type caster should probably not include (here) type dressing benches (because they can be used for hand casting as well). Machines such as these should be identified in the section on "Operating Context" in the Identification division. But a Benton Engraving Machine (vertical or other) should include the Benton Cutter Grinder (or a note that you don't have one) because it is so tightly associated with the main machine.

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23 This happens often (especially with Bridgeport milling machines). It will destroy a machine.

24 Some specialized knowledge of the machine can help here. There is an adjusting screw on a Thompson Type Caster which requires a long but quite thin wrench (which is not easy to find).

25 For good examples see both the standard machine tool kit and the oiler service kit supplied by the Ludlow Typograph Company for their Elrod Stripcasting Machine.

Identify associated equipment which isn't generally thought of as machinery. Examples: Linotype operator's cabinets, operator's chairs, matrix cabinets, type receiving stick racks.

Indicate here both what should be present with this machine and what you actually have.

9.7.8 - Replaceable Standard Components

Examples: Belts. Indicator lights. Note that some formerly standard components are becoming increasingly difficult to replace (e.g., incandescent lights). Take care to understand the full use of components. For example, the light at the top of a Wiebking/Ludlow pantograph standard is a regular 20th century incandescent Edison-socket light bulb. However, it is not a light intended for illumination. It is a speed indicator, showing by its brightness the speed of the motor. Modern LED replacement bulbs may not be suitable.

There is another issue with standard components. Since they're easy to replace (and indeed were intended to be replaced), it is easy to replace them. This isn't a problem unless there was information present in the original which is lost during replacement. A good example of this is grease.

Some time ago on the major online forum of Teletype collectors the issue of regreasing old teletypes came up. In this discussion it was pointed out that if we simply strip all of the existing grease off of a machine (for example, one which had just been taken out of preservation from the mid-20th century) we would lose all information about what kind of grease was used. It became clear in the discussion that many in the collecting community regarded the preservation of old grease as just about the stupidest thing a [highly derogatory term here] museum curator could do. If the goal is simply to see cool shiny teletypes in operation again, then they are correct. But if the goal is to respect the history of the machine and honor the memory of those who used it in commercial and military situations, then they are incorrect.

9.7.9 - Consumables Required

Examples: Typemetal. Matrix planchets. Fuels (gas, coal).

There may be issues here for the future. Coal-fired machines, for example, may require different fuels in the future.[26]

9.8 - Differences from Similar Machines

The question of "what is a similar machine" must be answered on a case by case basis.

For the Benton pantograph BEM2a-53 at CircuitousRoot, it is interesting to note differences between it and other Type 2a Benton pantographs - machines which are nominally "the same," but which differ in details. For example, machine No. 55 at the Letter-kunde Press in Antwerp lacks the rotating feature on the pattern table which is present on No. 53.

26 As I write this in 2022, heritage railways in England are experimenting with the use of "e-coal" alternatives to traditional coal.

It may or may not be considered useful to describe differences between less similar machines. For example, it may be useful to enumerate differences between BEM2a-53 (a Type 2a pantograph) and BEM No. 99 (a Type 2b pantograph), but it may not be useful to differentiate it from the surviving derivative Type 1b, etc. machines.

9.9 - On Specifications and Technical Documentation

As a final note,[27] Frederick Brooks, in his classic study *The Mythical Man-Month* (Brooks 1975), summarizes the elusive goal of precision in technical writing in a way which is specific to the subject of "differences from similar machines" but which also applies to documentation as a whole. He is discussing the overall architectural definition manual, the *Principles of Operation*, for the IBM System/360 family of computers (introduced in 1964):

> The unity of [IBM] System/360's *Principles of Operation* springs from the fact that only two pens wrote it: Gerry [Gerrit Anne] Blaauw's and Andris Padegs'. The ideas are those of about ten men, but the casting of those decisions into prose specifications must be done by only one or two, if the consistency of prose and product is to be maintained.
>
> ...
>
> I think the finest piece of manual writing I have ever seen is Blaauw's Appendix [G] to *System/360 Principles of Operation.*[28] This describes with care and precision the *limits* of System/360 compatibility. It defines compatibility, prescribes what is to be achieved, and enumerates those areas of external appearance where the architecture is intentionally silent and where results from one model may differ from those of another, where one copy of a given model may differ from another copy, or where a copy may differ even from itself after an engineering change. This is the level of precision to which manual writers aspire, and they must define what is *not* prescribed as carefully as what is. (62-63)

27 If you will forgive me. I am a second-generation programmer whose father started in 1958 and I spent my career in the mainframe computer world. I recall reading Brooks as a teenager and misreading the title as *The Mythical Man-Moth*.

28 (Blaauw 1964).

10 - Discussions, Division II (Research)

10.1 - Sources of Information

These include:

- Published literature (with links or biblio, reprinted in the Archive if possible).
- Unpublished literature (which should be kept in either the Archive or Private Archive).
- Surviving experiential knowledge (ask an interview everyone you can).
- Every photograph you’ve taken of the machine.

10.2 - Studies

These are entirely optional. They may also develop into standalone works which then may be incorporated here by reference.

10.2.1 - Historical

As an example, part of the history of the Benton Engraving Machines involves dispelling the myth that they were the first pantographs used in the mechanical cutting in the typemaking process. (Schraubstädter at the Central Type Foundry was cutting matrices by pantograph two years before Benton was cutting patrices and punches. By the time Benton was cutting matrices directly circa 1899 you had your choice of commercial matrix engraving services from Werner/Schroeder and from Wiebking.)

10.2.2 - Technical

Old machines are inherently obscure (especially in the digital age). There may be a need for essays on some of their constituent technologies. One example, relevant to Benton Engraving Machines, might be an essay on the geometry of pantographs (with special reference to single-arm pantographs).

10.3 - Archive

Computer storage is cheap now. Time spent looking for things is expensive. The Internet is cemetery of empty graves which once had the thing you were looking for. Keep local copies of all of the information you find about this machine.

For information which can be reprinted, keep it in a freely viewable archive.

10.4 - Private Archive

As noted earlier, sometimes information cannot be reprinted (usually because of copyright, permissions, and licensing issues). This should be kept in a private archive.

10.5 - Secret Archive

You may have been told things in confidence in such a way that you have promised never to reveal even the fact that you know them. For example, you may have been shown a photograph taken in an archive or museum which strictly forbids photography. If it became known that this photograph had been taken, the person taken it could be denied future access to this resource. The world of old typecasting machinery is small, and it is relatively easy to figure out who might have seen what. In such cases, ethics require that you cannot even make it known that you know this information.

If this occurs, this information must be preserved, but it must be preserved in a completely secret archive in your own personal library (physical or digital). At some point in the distant future, when institutions have changed and/or people have died, it can then be revealed.

It may be argued that this kind of secrecy has no place in scholarship. This is true. But you have not created this situation. It comes out of both intellectual property law and the desire for power which leads to attempts to control and privatize information. Both of these things are attacks on scholarship.

11 - Discussions, Division III (Practice)

11.1 - Rigging Notes (and machine bases, if present)

(See also Overall Dimensions and Weights, above).

These are things that the next person to move this machine would like to know:

- Minimum door width it will pass through; what can be removed to help?
- Minimum height it will fit under; what can be removed to help?
- What can be field stripped from the machine easily?
- What should not be removed unless necessary
- What parts are spring-loaded and dangerous even with the power off?
- Safe attach points, safe hoisting and lifting points?
- Unsafe attach/hoisting/lifting points?

If used, how should the a pallet jack be positioned on the machine? Will a standard width pallet jack fit? Narrow?

Are there through-holes in the base to screw the machine down? If so, how large are they?

What parts are loose and will fall off onto the highway?

There are many more items which could be added here. What got you into trouble when you moved the machine here? Sooner or later, it will be moved again.

11.2 - Installation Requirements and Millwrighting Procedures

Take these from factory or other docs if available. Construct/reconstructed them if necessary:

- Floorspace requirements
- Clearances around machine
- Installation floor plan(s)
- Floor weight capacity requirements.
- Service types, capacities, and locations

Installations which are open to the general public or are subject to industrial oversight will have further requirements, but these are really external to the machine dossier.

11.3 - Identification of All Controls

Every modern consumer product has this. Very few old machines ever did. Some had controls so well camouflaged that some operators have recalled only discovering them by hitting them with a broom by accident while sweeping up.[29]

11.4 - When Can / Can't the Machine Safely Be Cycled

This is very important. People will try to do it; it is human nature. But it can damage the machine and injure the person.

11.5 - Operating Experiments / Experiences

Especially for an unusual machine, it can be a good idea to record your journey to making it operational again. This can also make for good publicity / social media material.

11.6 - Operator's Manual (Draft)

Most old machines had inadequate operator's manuals. Some had none at all. You need a good one and you will have to write it yourself.

Manuals begin as notes. Start the manual as soon as possible as an informal document and put it here in the machine dossier. Polish it later for publication as an external public document.

29 An example is Mergenthaler Linotype Part E-1353, First Elevator Slide Recasting Block. If you've never cast borders and have never read p. 119 of *Linotype Keyboard Operation* (Mergenthaler Linotype. 1930), and you happen to knock it into position with your broom while sweeping up after your shift, you'll be quite puzzled as your Linotype misbehaves the next day.

12 - Discussions, Division IV (Re-Engineering)

12.1 - Physical Survey

12.1.1 - Parts List

12.1.1.1 - Choice of a Part Symboling System

For each machine, define a part symboling[30] system. If the manufacturer's parts catalogs or parts price lists survive, use their symboling system. If not, make up your own. There are several models to choose from. For a further discussion of some of these (and a reprint of Wilfred Bancroft's article introducing the Monotype system) see the CircuitousRoot Notebook "Part Symboling Systems."[31]

- Monotype - based on dividing the machine into groups and numbering the parts within them.[32]
- Mergenthaler Linotype - an alphanumeric system probably based on the letter designations of the now-lost original presentation drawings for the parts books.
- Ludlow Typograph - a mostly numeric system (with modifications) which serves as a good example of why numeric systems are hard to use.
- Thompson Type Machine Company (pre-Monotype) - an alphanumeric system
- "Hunslet" Austerity Locomotive spare parts list - a slightly better organized numeric system (Hunslet ca. 1946)

If you're looking for further information, search offerings of publishers to the enthusiast communities for steam locomotives and vintage aircraft. They sometimes reprint old parts catalogs. I presume that there must be many other examples from the modern automotive and aircraft industries.

12.1.1.2 - Illustrated Parts List

One thing that I learned during my apprenticeship at Skyline Type Foundry is that sooner or later every document published by a manufacturer will lie to you - except one: the parts price list. That's the document where they listed what they'd sell you, and they had to get it right.

More generally (because machines such as the Benton pantographs never had parts price lists), a parts list is the basic construction document for any machine because it lists everything that's in the machine. If you don't know this, you don't really know anything.

12.1.2 - Detailed Parts Survey (Descriptions and Measurements)

Include field sketches. Record the precision and accuracy of your measuring tools. Estimate allowances and tolerances. It is a good idea to have a solid background in the engineering and machine shop (or other manufacturing) practices of the time in which the machine was built.

30 Symboling" rather than "numbering" because often they aren't just numbers.
31 https://www.CircuitousRoot.com/artifice/symboling/index.html
32 The actual Monotype system was quite sophisticated and it requires considerable explanation. Note also that their terminology shifted from that of Wilfred Bancroft's initial article.

12.2 - Interfaces

The specification of a machine describes its interfaces with the operator (or rigger, or millwright, etc.)

The interfaces described here are those of interest to someone engineering or re-engineering a new capability for the machine. For example, you might wish to create a new matrix holder for a Benton Engraving Machine which handles a style of matrix not before used with it. To do this, you need to know the interface between the BEM and its matrix holder. An operator never needs to know this, but an engineer expanding the capabilities of the machine does.[33]

12.3 - New Technical Materials

12.3.1 - Design Studies

Given an interface (or as you do the research to define an interface), what are the processes you had to go through to make a new component? For example, what kind of ATF matrix size, drive, lining, etc. information was required? How did this influence your design.

This may also include studies re-engineering existing parts. For example, it has in the past made sense to re-engineer the follower holder for other BEMs - and as I write this I’m contemplating doing the same task in a different manner for BEM2a-53.

12.3.2 - CAD Models

These are not necessary but they are extremely useful - not only for generating 2-D engineering drawings but also for generating technical illustrations for use in other documents.

12.3.3 - 2-D Manufacturing Drawings

For reasons discussed elsewhere in this document, full traditional manufacturing detail drawings with GD&T information, intended for a manual machinist, are essential for the future of the machine.

CAD models of the 2020s are not durable over time and are not a safe or responsible vehicle for preserving information.

12.3.4 - Manufacturing Operations Sheets

If you make a part, record the operations.

(The Star Parts drawing archive of Linotype and Intertype compatible parts, preserved at CircuitousRoot, has many good examples of traditional 20th century manufacturing operations sheets.)

33 It is also necessary if you are making a new matrix holder without an example to replicate. This has been the case for BEM2a-53.

12.3.5 - Other Views/Renderings

Many other things can be generated from 3-D CAD models besides 2-D manufacturing drawings. These include:

- General arrangement drawings (or renderings in 3-D).
- Exploded views in 3-D for parts lists and maintenance manuals.
- Cutaway 3-D views for understanding hidden elements.

13 - Discussions, Division V (Plans and Activities)

13.1 - Record of Actions Taken and Modifications Made

Every change you make to the machine should be written down, signed, and dated.

13.2 - Plans for the Machine's Future

This is up to you, but note that "do nothing" is often a good plan. Good intentions and busy volunteers can be the worst enemy of a machine.[34]

34 See the discussion of the effects of a "rogue group of volunteers" at the Larz Anderson Automobile Collection, by Evan Ide in (Simeone 2012, 44-53 and esp. 47).

14 - Discussion, Division VI (Bibliography)

There must be a single bibliography for the entire machine dossier which includes not only works cited in any of the documents written for the dossier but also works not cited which might usefully be consulted by a user of the dossier.

Note that this differs from the modern trend in scholarly style to strictly distinguish between list of works cited (which must contain only works cited) and more general bibliographies. Such a split is a bad idea: it makes documents difficult both to maintain and to use.

15 - Discussions, Division VII (Auxiliary Material)

15.1 - Glossaries of Specialized Vocabulary

15.1.1 - Authentic Terms Unique to this Machine (e.g., "quill" for Benton)

These are terms of art (controlled vocabularies) for the machine, which are known to have been used by the makers or operators of the machine during its regular service life. An example would be the term "quill," which we know was the term for the cutting spindle of a Benton Engraving Machine at American Type Founders (documented in this case by Theo Rehak).

15.1.2 - Terms Introduced In the Dossier for this Machine

Unless substantial prior documentation exists (such as parts price lists from the manufacturer), it will probably be necessary to create a controlled vocabulary for the machine consisting of terms invented because you need to call X by some name. An example would be the term "bridge" as applied to a Benton Engraving Machine. I just invented this term. It is highly unlikely that this was the term employed by Linn Boyd Benton or American Type Founders. But no record of the name of this component survives. It doesn't really matter what we call it so long as we all call it the same thing.

15.1.3 - General Terms of the Period Employed Here

The language of older machines is no longer well known. For example, anyone in the early 20th century would have known what a "standard" was: a post/pillar functioning as a supporting element in a machine. On an *ad hoc* basis, it may be useful to list such terms when relevant.

15.2 - Stylistic and Scholarly Discussion for this Machine Dossier

15.2.1 - Stylistic Decisions

These are matters of 2-dimensional visual presentation on the page. These can be matters of strong opinion. Here's your chance to point out that you actually did think about the thing you did which someone else considers a dreadful error.

15.2.2 - Known Layout Bugs

Because the tools used to maintain these documents must be open-source, it is likely that they will have problems which aren't worth fixing. (In the case of Libreoffice, it simply has problems. In the case of LaTeX, it is so complicated to use that sometimes it isn't worth fixing the problem.) Record these. This is all open-source; if somebody really doesn't like it, they're free to fix it.

15.2.3 - Scholarly Decisions

Generally it is sufficient to pick a style guide which addresses issues of scholarship and then to stick with it. I tend to use the *Chicago Manual of Style* (17th edition, at present). But there are cases where these are insufficient or where some good reason demands that you do something different. Record these cases.

16 - List of Tools and File Formats

(This section contains strong opinions.)

Here is an incomplete list of some tools which at the present time are workable for machine dossiers:

- For written texts:
  - TeX/LaTeX[35], for larger and more sophisticated documents.
  - LibreOffice or Apache OpenOffice (.odt) for short documents.
  - Plain ASCII or Unicode text files - often, the simplest is the best.[36]
- For spreadsheets:
  - LibreOffice Calc or Apache OpenOffice Calc (.ods).[37]
- For databases: don't use databases.[38]
- For 2D graphics (CAD, vector graphics, photo editing):
  - FreeCAD (but its interface is terrible and its notions of what constitute a DXF file are not really portable to other 2D CAD program) or the opens source level of QCAD.
  - Inkscape (for vector graphic drawings).
  - Krita (for photo and bitmap image editing).[39]
- For 3D CAD / modeling:
  - Free or low-cost tiers of commercial CAD (Onshape, Fusion360), but without reliance upon the survivability of your internal models.[40] See the notes on STEP and 2-D drawings below.
  - (less preferable) Paid tiers of commercial CAD, with the same caveats.[41]

Any file format which is supported by the tools listed above will probably work. There are a few which should be avoided, however.

35 Actually (2022) the XeLaTeX derivative, for better support of nonwestern writing systems. It is astonishing that Knuth's TeX, developed in the 1980s, remains the only viable open source solution for publishing. Open/LibreOffice is fine for short documents, but bogs down to the point of being useless for large, image-heavy documents (yes, I've tried). Scribus just isn't there yet.

36 UTF-8 encoding is preferable. ASCII is a proper subset of Unicode and is expressible in the 7-bit simplest fallback for UTF-8.

37 Spreadsheets can also be used for simple 2-D arrays of non-numeric information.

38 Databases seem at first to have many advantages. But all databases involve locking up data in non-human-readable formats. This means that when the software fails it will be that much harder to recover the data.

39 Or The GIMP, which is capable but suffers from unbearable hubris on the part of its maintainers.

40 Beware of un-emphasized restrictions. For example, in 2022 Dassault is offering a low-cost "maker" edition of SOLIDWORKS (3DEXPERIENCE SOLIDWORKS for Makers). It looks appealing, but the SOLIDWORKS files it creates cannot be imported into full commercial versions of SOLIDWORKS. So if you model a part for your machine with the idea that you can send off the `.sldprt` file to a machine shop for fabrication, you'll be disappointed when you find that they're running a commercial SOLIDWORKS license and can't read your file.

41 But to be honest this is exactly what I am doing at the present time (2022), with Alibre Design ("Expert" level) CAD.

The JBIG2 format silently corrupts data in a way which is nearly impossible to detect and completely impossible to correct.[42] JB2 does the same. JB2 is used by DejaVu. None of these should ever be used. It is difficult to comprehend why this format was ever developed.

The internal formats used by photo editors such as Krita (.kra) and The GIMP (.xcf) are open, but they're never really going to catch on and should be avoided. Krita, sensibly, makes this easy. The GIMP makes it difficult.

The "STEP" (ISO 10303) CAD standard is extremely large. It is really a collection of many standards. So just telling your CAD program to export a STEP file doesn't really mean much unless you know specifically what portions of ISO 10303 are supported in this export (and to what degree). At the time of writing, and to the best of my knowledge, support for STEP AP242 (models with tolerances) is present only in higher-end commercial CAD products (and then with caveats).

For CAD models, *always* generate 2-D engineering drawings. Until ISO 10303-242 (STEP AP242) has matured and there is widespread support for it in open source CAD (a situation which may never occur), 2-D engineering drawings are the only form of proper toleranced engineering data which has any chance of surviving in the long term.

42 Unfortunately, Google Books uses JBIG2. Information from its scans is always suspect. The Internet Archive used to use JBIG2, but no longer seems to (and seems to be re-encoding scans so as not to use it).

17 - Useful or Background References and Resources

17.1 - Examples of Machine Dossiers

As of the current draft of this document there are no examples of machine dossiers based upon the scheme laid out in this document, because I'm writing this document in order to help me create the first machine dossiers. But the first one that I hope to bring to some state of utility is the dossier for the Benton Engraving Machine (vertical pantographic typographical engraving machine, BEM2a-53) in my care. This will be distributed at:

https://www.CircuitousRoot.com/artifice/letters/pantocut/benton/index.html

The next machine dossiers will be on the No. 3 1/2 Barth Type Casting Machine (60 pt mold) and the Wiebking/Ludlow pantograph engraving machine (a horizontal typographical pantograph), both also in my care. At present, I have some material on the Barth online, collected with the same purpose as a machine dossier but organized according to earlier notions:

https://www.CircuitousRoot.com/artifice/letters/press/noncomptype/casters/barth/index.html

The material currently online about the Wiebking was written some time ago with a different mindset:

https://www.CircuitousRoot.com/artifice/letters/pantocut/wiebking/index.html

If you know of other projects which have created something like a machine dossier, I would be interested in learning of them.

17.2 - History of Technology Transfer

The transfer of technology has been going on for as long as there has been technology. Sometimes this has been accidental, sometimes surreptitious ("industrial espionage"), and sometimes acknowledged and documented. Today in the USA we would associate a "Technical Data Package" (TDP, see below) with this (at least in the arena of military procurement), but in earlier periods the standards for documentation were less formal. Because a machine dossier is a form of technology transfer (to the future), the study of the documentation of technology transfer in the past is important. The period from the late 19th through the mid- 20th centuries should be of particular interest. There were many instances of the transmission of complex technologies both between companies and between countries. These included:

- Companies establishing overseas manufacturing facilities
- The transfer of a product to a developing country[43]
- Parallel manufacturing between countries of similar industrial capacity[44]

43 The licensed transfer of aviation technology to Japan from the West is an important instance of this. See (Melzer 2020).

44 For example, in World War II many products developed in England were manufactured in parallel in Canada (in case the English factories were bombed) and in the US (because of the vast manufacturing capability the US then had). There is an interesting but unexplored aspect of this history of dimensioning and tolerancing here. Anecdotal reports say that US companies had to re-engineer English designs for the Merlin aircraft engine because they did not meet standards permitting interchangeable manufacturing without hand fitting. This may well be true, but I have not yet discovered the actual evidence for it.

Unfortunately, I have not yet discovered any surviving example of the documentation package which accompanied a technology transfer. I would particularly like to find one in the period from, say, 1880 through 1939.[45]

This is a vast but under-researched subject. For a good example of what can be done, see Jürgen Melzer's *Wings for the Rising Sun* (Melzer 2020). Melzer is not an engineer, but he was an airline pilot before his academic career and he does understand technology (in a way that many economists and historians do not).

17.3 - History of Technical Data Packages

Writing a complete machine dossier is the same task (from a different perspective) as creating a "technical data package" to transfer knowledge of a product. The only difference is that a modern TDP is intended to capture a product so that it can be transferred to another company or country while a machine dossier seeks to transfer this information to the future.

The current US military standard for TDPs is MIL-STD-31000B (2018), *Dept. of Defense Standard Practice: Technical Data Packages*. It comes out of a long history of earlier standards dating back at least to the 1970s. These began as specifications of the kind and quality of engineering drawings which would be considered acceptable for a military contract.[46]

Although they exist, I do not have access to any complete TDP for a current product. I don't think that I'm looking in the right places.

17.4 - Reverse Engineering of Physical Machines

TO DO

There is a literature here, but I am only now beginning to discover it.

See also the CircuitousRoot Notebook "On the Reverse Engineering Big Old Machines" .

17.5 - CAD: GD&T, AP242, MBE

The types of drawing and drafting involved in a machine dossier can run the entire range. A freehand sketch is often the best thing to do. Traditional paper, pencil, and ink drafting tools are also just fine. After all, they were probably used to make the machine in the first place.

At the other end, modern 3-D CAD programs can be appropriate as well. But there are two issues with them. The first has to do with cost and openness, as discussed earlier. But the second has to do with where we are in the evolution of these tools.

In the 20th century, progress in 2-D drafting was to a great extent progress in dimensioning and tolerancing. From the work of Parker in and following World War II (Parker 1958)[47] this has led to "Geometric Dimensioning and Tolerancing" (GD&T) as codified in the ASME standard Y14.5, *Dimensioning and Tolerancing*[48] But CAD in industry is now 3-D modeling and there is a move away

45 Or, really, anything prior to the collapse of quality in drafting in the 1970s.
46 See for example DOD-D-1000B (1977), *Military Specification: Drawings, Engineering and Associated Lists*.
47 Parker's work in WWII has not yet been published. Work in this field evolved through the 1950s, often under the rubric "true position."
48 The ISO equivalent standards are contained within the ISO's "Geometrical Product Specification" (GPS) standards, especially ISO 1101 "Geometrical Product Specifications - Geometrical Tolerancing ..."

from generating 2-D drawings from the 3-D models. Including GD&T information in the 3-D models itself was addressed in ASME Y14.41, *Digital Product Definition Data Practices*.[49] But Y14.41 really just provides guidance on what a 3-D rendering of a 3-D GD&T model should look like. It says nothing about the actual model encoding. These issues have begun to be addressed in one aspect of the huge ISO standard 10303 ("STEP"[50]), its "Application Protocol" 242 (AP242).

In the early 21st century there is has also been an intermediate effort to move information from 2-D CAD drawings to other computer data structures. See (VDA 4953 (2015)). Although this is clearly an intermediate stage, it is worth looking at because one of its goals is eliminating duplication of information between drawings and other documents. (If something appears in two places, it can be wrong in one of them. Murphy's Law tells us that it will be.)

In related developments, there is also at present significant hype around the term "Model Based Enterprise" (MBE) in CAD. There are some very good ideas behind MBE (in particular its need for integrating tolerancing into engineering models via new portions of the STEP standard such as AP242). But there are also some very bad ideas, from the point of view of long-term preservation (especially the desire to eliminate 2D drawings, which remain the only viable solution to long-term documentation). "MBE" is also at present the exclusive province of expensive and proprietary systems. It is all about selling expensive software to your company so that (they say) you can make more money now. It is not about long-term knowledge preservation for the future.

When creating CAD models for machine dossiers (in the 2020s) it is probably a good idea to be aware of these developments. But they are not yet widely supported in the CAD tools likely to be available to collectors of old machines.

17.6 - From the Curatorial Perspective

TO DO

There are well-established procedures in the world of museums for documenting items. I have not yet investigated it.

I presume that it is at a level which falls short of both the documentation necessary for "restorative conservation" (see below) and machine dossiers as described here. Still, it may constitute a necessary minimum.

49 The ISO adaptation of this standard is ISO 16792.
50 "STandard for the Exchange of Product model data".

17.7 - Restorative Conservation

This is John Watson’s term for preserving mechanical objects in operating condition while still respecting the principles of conservation.

For a discussion of this subject on CircuitousRoot, see: The Past and the Future: Preserving Machinery and Processes (https:www.CircuitousRoot.com/artifice/past-future.html)

Here are a few basic reference which emphasize the reasons for restorative conservation (which is Watson’s term for it) rather than technical details for the workshop or laboratory:

Watson

The best work I have found on this subject is John Watson’s A*rtifacts in Use* (2012). Watson work with pipe organs, but what he says is relevant to any big old machine which gets in the way and which will be removed and destroyed if it isn’t perceived as doing a job. A pipe organ blocking a beautiful stained glass window is, in this sense, identical to a Barth type caster taking up valuable floorspace.

Watson’s book provides (at least) two things not present here: (1) a much deeper and more nuanced philosophical investigation of the spectrum which runs from rebuilding to full conservation and (2) a more project-based approach to restorative conservation. One major difference between Watson’s field (pipe organs) and my own field (obsolete type-making machinery) is that there is a great body of practical and current institutional knowledge for his field. So much knowledge of type machinery has been lost (so quickly) that sometimes it feels like archaeology. So the machine dossiers discussed here take are heavily involved with things like explaining what the machine does, documenting power inputs, and writing instruction manuals. Watson doesn’t have to do any of this for pipe organs.

Simeone *et al.*

It is nearly impossible to convince older collectors that gussying up an antique machine so that it is shiny and pretty is what it is: vandalism. However, if any argument can accomplish this, it is Fred Simeone’s *The Stewardship of Historically Important Automobiles.* (Simeone 2012). It makes the case that so-called “restoration” not only destroys our history but also destroys the monetary value of the item. If nothing else, money talks.

18 - Background of this Document

In deciding how little or how much of the approach described here you might wish to apply to your own machines, it might be useful for you to know something of its origins.

I am a private collector with no training at all in museum conservation practices. I have a doctorate in English and American Literature and had a career largely in technical writing; I have no formal training in engineering. I am an amateur or hobby machinist - but with an emphasis on amateur! Through a set of happy accidents and far too many machine moving trips, I have managed to acquire a large collection of the machinery once used to cast letterpress printing type. Some items in this collection are rare, but none of it is of monetary value. Indeed, its dollar value is probably negative. It would cost more to haul it to the scrapyard than anyone would ever be willing to pay for it. Yet it contains items of great and in some cases unique importance to our cultural heritage.

The small world of letterpress printing and typecasting enthusiasts is still at the stage that other areas of preservation were decades, or centuries, ago: where it was once acceptable to "restore" a rare automobile until only a few molecules of the original metal remained, or to buy an Old Master painting and have a local artist paint your dog into the scene. Yet the world of type machinery differs from, say, the worlds of antique furniture or fine art collecting. In those worlds, static display is a viable option. But typecasting machines more resemble the pipe organs which are the subject of Watson's *Artifacts in Use* (Watson 2010). They're big, in the way, complicated, and difficult to understand on their own. If they aren't being used, they will be preserved only rarely and poorly.

The "machine dossier" described here is a document which walks[51] a fine line between traditional private collectors of and enthusiasts for machinery, on the one hand, and responsible conservation, on the other. The private enthusiast whose goal is to run the machines "as they should be run" needs to realize at least two things: First, that doing "whatever it takes to make a machine work" was a part of the machine's life only when it was in real production in its heyday. It is not appropriate today. Second, that sandblasting and wire brushing away the history of a machine just to make it shiny and pretty is vandalism. All it shows is how little you respect the machine. But on the other side, the museum curator or conservator needs to realize that for all but the most fragile of these machines static display is inappropriate to the point of being unethical. Museums serve us poorly: in reality, a machine in a museum is just in temporary storage on its way to the scrapyard. If the typecasting machine in your museum collection isn't doing something then it is just a matter of time before some administrator decides to simplify their lives by deaccessioning it. This has happened over and over and it will continue to happen. The private enthusiasts aren't wrong in their criticism of museums.

The hard part about walking the line between these two extremes, as these machine dossiers begin to do, is that both sides know that you're wrong. Enthusiasts, at least, won't be shy about telling you so.

For more (but still incomplete) discussions of this see the CircuitousRoot Notebooks "The Past and the Future," https://www.CircuitousRoot.com/artifice/past-future .

51 Insofar as documents are ambulatory.

19 - Bibliography

Acronyms:

- ANSI. American National Standards Institute
- ASA. American Standards Association
- ASME. American Society of Mechanical Engineers
- DOD. United States Department of Defense.
- ISO. International Organization for Standardization
- USASI. USA Standards Institute

Numbers in titles appearing here are ordered numerically, not alphabetically. Thus Y14.41 comes after Y14.5, not before. The punctuation for dates here generally follows the *Chicago Manual of Style* (17th ed., 2017) except for standards documents where the conventions of the issuing standards organization prevail.

ASME Y14.5-2018. *Dimensioning and Tolerancing.* NY: ASME.

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ASME Y14.41-2019. *Digital Product Definition Data Practices*. NY: ASME.

Preceded by ASME Y14.41-2003 (R2008) and ASME Y14.41-2012.

ASME Y14.100-2017. *Engineering Drawing Practices.* NY: ASME.

Preceded by MIL-STD-100G (1997), ASME Y14.100-2000, ASME Y14.100-2004 (R2009), ASME Y14-100-2013. Consolidates ASME Y14-41-2002 (R2008).

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ISO 16792:2021. *Technical Product Documentation - Digital Product Definition Data Practices.* Geneva, Switzerland: ISO.

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20 - To Do

Review (Watson 2010) to see what parts of his approach should be incorporated here.

Find a complete example of the documentation for a technology transfer in the period from about 1880 through the 1960s.

Find examples of 21st century Technical Data Packages.

Investigate resources for reverse engineering of (old) mechanical things. (Most of the literature of reverse engineering addresses software.) The literature on mechanical reverse engineering is not extensive. See especially (Ingle 1994).

Investigate resources for curatorial practices (for "From the Curatorial Perspective" section).

There is some duplication of descriptions/context within the "Overview" section. Factor this out more carefully. It is probably best to write through some examples first.

21 - Revision History

Rev. 4d, 2023-02-28. Many typos.

Rev. 4c, 2023-02-27. Minor corrections discovered after uploading.

Rev. 4a, b, 2023-02-27. Additions reflecting experience with BEM2a-53's Machine Dossier.

Rev. 3, 2022-12-23. Many small changes.

Rev. 2, 2022-12-22. Nominally complete draft (with a few holes). Start generating content against it to test it.

Rev. 1, 2022-12-21. Incomplete draft.