

# Patent technology classifications for early aeronautics

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Views and findings are those of the author, not the Bureau

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# Patent classification

- Patent agencies usually have categorized patents by technology, function, and/or industry
- Main agenda usually is to simplify search for prior art
  - By their own examiners
  - To organize their own offices/examiners
  - By external potential applicants and agents
  - Indirectly to reduce or ease later legal cases
  - (Not to classify technologies for academics)
- Organizing \*future\* innovations is interesting & difficult.
- Goal here: Compare 1830-1920 classification systems
  - See how aeronautics gets put into them
- Work in progress – I'm gathering aero patents from as early as possible to 1920 and classifying them

# Example: French patent docs show the class

RÉPUBLIQUE FRANÇAISE.

OFFICE NATIONAL DE LA PROPRIÉTÉ INDUSTRIELLE.

## BREVET D'INVENTION.

VI. — Marine et navigation.

4. — AÉROSTATION.

N° 342.188

**Perfectionnements aux machines aéronautiques.**

MM. ORVILLE WRIGHT et WILBUR WRIGHT résidant aux États-Unis d'Amérique.

**Demandé le 22 mars 1904.**

Délivré le 1<sup>er</sup> juillet 1904. — Publié le 1<sup>er</sup> septembre 1904.

(Demande de brevet déposée aux États-Unis d'Amérique le 23 mars 1903. — Déclaration du déposant.)

Cette invention est relative à des perfectionnements aux machines aéronautiques dans lesquelles le poids est contenu par les perfection-

nant à l'ensemble de la machine une grande rigidité et solidité transversales. Les articulations à l'ensemble de la machine sont...

# Patent classification “families” before 1920

- German, Scandinavian, Austrian, (post 1910) Dutch
- U.S. (USPC) and Canadian after about 1910
- French and Belgian (how similar? To be tested)
- Others seem distinct (Early U.S., British, Australia, Switzerland) – need more info
- Later international classifications IPC and CPC are definitely a family, with many rounds of updates
- It must be possible to find out who copied who.
- Independent of that I'd like to MEASURE which systems are similar and where they differ.

# U.S. patent classification of 1836-

Class	Name
1	Agriculture
2	Metallurgy
3	Fibrous and Textiles substances
4	Chemical Processes
5	Calorifics
6	Steam and Gas Engines
<u>7</u>	Navigation and Maritime Implements
8	Mathematical, Philosophical, and Optical Instruments
9	Civil Engineering and Architecture
10	Land Conveyances
<u>11</u>	Hydraulics and Pneumatics
12	Lever, Screw, and Mechanical Power
13	Grinding Mills and Mill-Gearing
14	Lumber
15	Stone and Clay manufactures
16	Leather
17	Household Furniture
18	Arts
<u>19</u>	Fire Arms and Implements of War
20	Surgical and Medical Instruments
21	Wearing Apparel
22	Miscellaneous
23	Extensions, Reissues, Improvements, etc.

Note some practices avoided later

- Class 23 is not technology, but administrative
- Overlap: an industry category (agriculture) and tech categories for engines, fuel, chemical processes.
- → a reapplication in a new field is a new invention? Or categorized in a place hard to find?
- So later systems organize more by narrow technical “function,” and less by industry

This classification has some similarities to the French classification of 1853. How similar is it?

# Classifications of French patents, 1853-1904

## 20 categories, changing one in 1896

Category #	Title	Title in English
1	Agriculture	Agriculture
<a href="#">2</a>	Hydraulique, sondage	Hydraulics, sounding
<a href="#">3</a>	Machines a vapeur	Steam engines
4	Machines appliquees aux matieres textiles, tissus	Applied machinery for textile materials, fabrics
<a href="#">5</a>	Machines et appareils divers, outils	Miscellaneous machinery and equipment, tools
<a href="#">6</a>	Navigation	Navigation
7	Construction, batiments	Construction, buildings
8	Metallurgie	Metallurgy
9	Quincaillerie, serrurerie, coutellerie	Hardware, locksmith, cutlery
10	Carrosserie, charronnage, sellerie, bourrellerie, corderie, broserie	Car bodywork, wheelwright, saddlery, saddlery, cordage, brushes
11	Arquebuserie	Archery and guns
<a href="#">12</a>	Instruments de precision	Precision instruments
13	Substances minerales, ceramique	Mineral substances, ceramics
14	Produits chimique, aliments, conservation des substances alimentaires, cosmetiques	Chemicals, food, food preservation, cosmetics
15	Appareils d'eclairage et de chauffage, combustibles	Lighting and heating appliances, fuels
16	Habillement, chapellerie, ganterie, chaussures	Clothing, headgear, glove, shoes
17	Beaux-arts, instruments de musique	Fine arts, musical instruments
18	Papeterie	Stationery, works of paper
19	Cuir et peaux (1853-1896)	Hides and skins (1853-1896)
	Chirurgie, medecine, hygiene (1896-1904)	Surgery, medicine, hygiene (1896-1904)
<a href="#">20</a>	Articles divers	Miscellaneous items

Main category	Subcategories	In English
I. Agriculture	I.1 Matériel et machines agricoles	I.1 Agricultural machinery and equipment
	I.2 Engrais et amendements	I.2 Fertilizers and soil improvers
	I.3 Travaux d'exploitation, génie rural	I.3 Farming operations, rural engineering
	I.4 Elevage et destruction des animaux, chasse, pêche	I.4 Livestock breeding and destruction, hunting, fishing
II. Alimentation	II.1 Meunerie et industries s'y rattachant	II.1 Milling and related industries
	II.2 Boulangerie, pâtisserie	II.2 Bakery, pastry
	II.3 Sucres, confiserie, chocolaterie	II.3 Sugar, confectionery, chocolate
	II.4 Produits et conserves alimentaires	II.4 Food products and canned foods
	II.5 Boissons, vins, vinaigre, tonnellerie	II.5 Beverages, wines, vinegar, cooperage
III. Chemins de fer et tramways (Railways and trams)	III.1 Voie	III.1 Tracks
	III.2 Locomotives, traction mécanique sur rail	III.2 Locomotives, mechanical traction on rails
	III.3 Traction électrique sur rail	III.3 Electric track traction
	III.4 Voitures et accessoires	III.4 Cars and accessories
	III.5 Appareils divers se rapportant à l'exploitation	III.5 Operations
IV. Arts textiles - utilisation des fibres et des fils (Textiles and fibers)	IV.1 Matières premières et filature	IV.1 Raw materials and spinning
	IV.2 Teinture, appret et impression, papiers peints	IV.2 Dyeing, finishing and printing, wallpapers
	IV.3 Tissage	IV.3 Weaving
	IV.4 Tricots	IV.4 Knitting
	IV.5 Passementerie, tulles, filets, dentelles, broderies	IV.5 Passementerie, tulles, nets, lace, embroidery
	IV.6 Corderie, brosse, ouates, feutres, vannerie, sparterie	IV.6 Ropes, brushes, wadding, felt, plaiting, wickerwork
	IV.7 Fabrication du papier et du carton	IV.7 Manufacture of paper and paperboard
	IV.8 Utilisation de la pâte à papier et du carton	IV.8 Use of pulp and paper cardboard
V. Machines	V.1 Appareils hydrauliques, pompes	V.1 Hydraulic apparatus, pumps
	V.2 Chaudières et machines à vapeur	V.2 Boilers and steam engines
	V.3 Organes, accessoires et entretien des machines	V.3 Organs, accessories and maintenance of machines
	V.4 Outils et machines outiles	V.4 Tools and machine tools
	V.5 Machines diverses	V.5 Miscellaneous machines
	V.6 Manoeuvre des fardeaux	V.6 Maneuvering loads
	V.7 Machines à coudre	V.7 Sewing machines
	V.8 Moteurs divers	V.8 Miscellaneous engines

# Later French patent classifications, 1904-1958

20 classes, reorganized and now divided into 99 subclasses

Here are the first 5 classes

# German system 1877-1900

- Had 89 categories, alphabetically listed
- This is an examination system, with high standards
- Class is shown on patent
- Elaborated only slightly before 1900 then hundreds then thousands of subclasses were added
  - (e.g. 77h, 77h group 3)

# Patent class is shown on the patent document

Otto Lilienthal MUSEUM KAISERLICHES PATENTAMT. PATENTSCHRIFT  
 — № 84417 —  
 KLASSE 77: SPORT.  
 OTTO LILIENTHAL IN BERLIN.  
 Flugapparat.  
 Zusatz zum Patente № 77916 vom 3. September 1893.  
 Patentiert im Deutschen Reiche vom 29. Mai 1895 ab.  
 Längste Dauer: 2. September 1908.

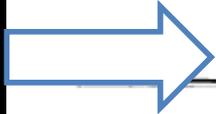
Bei dem unter Nr. 77916 geschützten Flugapparat hat sich der Uebelstand gezeigt, daß, wenn der Apparat die Luft unter sehr spitzem Winkel durchschneidet, die Vorderkante infolge der gewölbten Flächenform Druck von oben erhalten kann. Dadurch wird ein stabiles Durchsegeln der Luft gefährdet, und der Apparat aus seiner Flugrichtung gedrängt.

Um dieses zu vermeiden, wird die vordere Flächenpartie derart beweglich gemacht, daß dieselbe um die Vorderkante drehbar sich nach unten richten kann. Das in Fig. 1 schraffierte Flächenstück kann sich um die Achse *a b* nach unten, etwa bis in die Lage *c d* (Fig. 2) herabsenken, durch einen Luftdruck von unten aber wieder bis in die Lage *c e* erheben. Durch federnde Organe *ff* hat das schraffierte Flächenstück das Bestreben, die gesenkte Lage *c d* einzunehmen, und zwar ist der normale, auf diese bewegliche Fläche entfallende Luftdruck gerade ausreichend, um die Federn *ff* so weit zu spannen, daß das vordere Flächenstück in die

gehobene Lage *c e* gelangt und dadurch ein Theil der ganzen geschlossenen Flügelfläche wird. Hierdurch ergibt sich die Wirkungsweise insofern, als bei einer Luftdruckverminderung unter der schraffirten Fläche *c e* die federnden Organe die Fläche selbst nach unten drücken, wodurch der verminderte Luftdruck sich wieder ergänzt und aufrichtend auf den ganzen Apparat wirkt, bis die zu einem stabilen Fluge des Apparates erforderliche Lage wieder erreicht ist.

PATENT-ANSPRUCH:  
 Eine Ausführungsform des durch Patent Nr. 77916 geschützten Flugapparates, bei welcher der vordere Theil der Flügelfläche um die Vorderkante (*a b*) nach unten drehbar ist und durch federnde Organe *ff* nach unten gedrückt wird, so daß er sich beim Nachlassen des von unten wirkenden Luftdruckes nach unten dreht und dadurch ein den Apparat aufrichtendes Moment erzeugt.

Hierzu 1 Blatt Zeichnungen.



Otto Lilienthal MUSEUM OTTO LILIENTHAL IN BERLIN. Flugapparat.

Fig. 1. Fig. 2.

Zu der Patentschrift  
 № 84417.  
 PHOTOGR. DRUCK DER REICHSDRUCKEREI.

# British patent classifications

- Class not on patents themselves only later reports
- This is a registration system not an examination system
- Bennet Woodcroft a major founder, and did not want patent office to “examine”
- Wright patent goes into “aerial machines”
- Haven’t mastered the system(s) yet
- Not easily available in data so far
- Nuvolari and colleagues know it
- Many sources needed: *Abridgement of Patent Specifications; Subject-Matter Index; Key, ...*

# Classification evolution

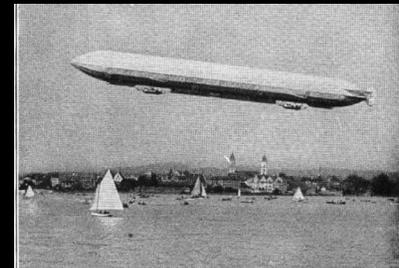
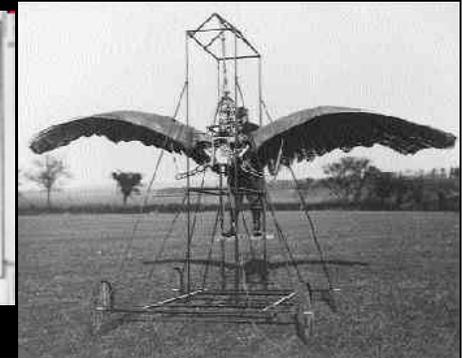
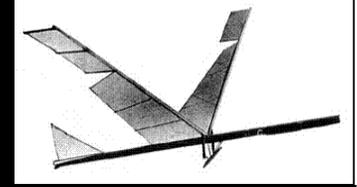
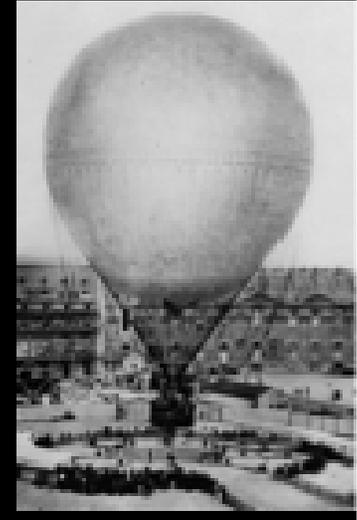
- There are more and more categories over time in every system
    - To aid search by examiners
    - And by applicants and agents
    - To organize patent offices, management and library
  - It's easy to split a category
  - Whereas it's difficult to reorganize deeply
  - Systems naturally become more elaborated without merging
  - For much more: Lafond and Kim 2018, Strumsky et al 2012, 2015
  - US has 36 categories in 1867, jumping to 145 in 1872
  - France has 20 from 1853-1904, then 99
  - Germany has 89 from 1877-1899 then hundreds
- Now, international standards have >200,000 classes (Source: [historicip.com](http://historicip.com))

# U.S. administrative response to complexity

- US Patent Office did oes classification for its own reasons before mandated by Congress.
- Classification is mandated 1836
- Much request for more support for classification staff
- 1898 a Classification Division is budgeted
- The Classification Division reorganizes and reclassifies and documents.
- The system is then stabilized after a period of much change and evolves into the “USPC” which is now generally available as data.
- Based on proximate function when possible, and industry, structure, effect, or product only when needed.
- 36 people in Classification Division in 1923 (Gustavus Weber book)
- Actual classification of a patent application is done by examiners. Goals include: feasible mastery by examiners; minimize lawsuits about priority.

# Aeronautics case

- Diverse and surprising ideas
- Balloons, rockets, kites, gliders, helicopters, ornithopters
- French 6.4 is “aerostation” (ballooning)
- German 77 is “Sport”
- After 1900 US 244 is Aeronautics
- British Class 4 is Aeronautics
- Likewise other countries create an “Aeronautics” eventually



# Propellers, an illustration

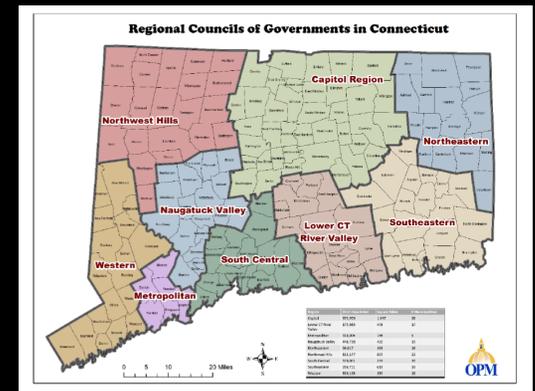
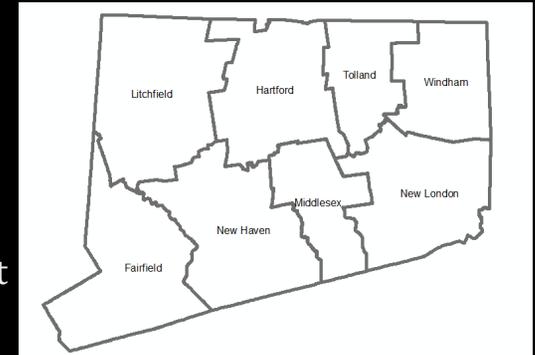
- In data set we label some patents “propellers”

In official systems those were classified as:

- French category 6 (1 case, early), 6.4 (71 cases), 6.3 (18 cases) 6.2 (12 cases)
- Germany: klasse 77 (11 cases), later 77h (3 cases), Austrian case 77d
- Belgium 47 cases all in class K
- Switzerland 1 case in 115 and 1 case in 129b
- USPC: several subclasses of 144 (50 cases), class 416 (8 cases), class 114 (2 cases)

# A way to compare category systems

- Given a sample that has been coded into two category systems, construct a “best match” for each category in the other system
- Analogous example: Connecticut has had 8 counties, and is switching to 9 regions. Census Bureau is adapting.
- Below is a table of counts of cities and towns in both category systems from Cassidy (2019)
- Let’s say we map the most-likely cases to the most-likely cases
- On average given the city’s region you can predict its county with 16% error
- On average given the city’s county you can predict its region with 20% error
- It’s not a symmetric distance but measures like these give a sense of how far apart the category systems are.



County	New 9 Regions (Councils of Government)								Total by county
	Fairfield	Hartford	Litchfield	Middlesex	New Haven	New London	Tolland	Windham	
Capitol Region		26					12		38
Lower Connecticut River Valley				15		2			17
Metropolitan	6								6
Naugatuck Valley	1	1	5		12				19
Northeastern						1	1	14	16
Northwest Hills		2	19						21
South Central					15				15
Southeastern						18		1	19
Western	16		2						18
<b>Cities and Towns in Region</b>	<b>23</b>	<b>29</b>	<b>26</b>	<b>15</b>	<b>27</b>	<b>21</b>	<b>13</b>	<b>15</b>	<b>169</b>

# For that we'll need dual-coded examples

- Having filed in country A, an inventor could also file for patent protection in country B.
- If approved both places we can see how they classified it; the patent has been coded into multiple systems.
  - (Nowadays the filing is just once for many countries.)
- It's challenging however to build up a database of "foreign filings" Balloons, rockets, kites, gliders, helicopters, ornithopters
  - We build those relationships in my aeronautics patent data, drawing from
    - (a) date the inventor made first filing
    - (b) whether patent applications have same diagrams
  - Not done yet

# Information theory comparisons of classifications

Shannon information or entropy measures:

Given there exists a set of labeled/categorized objects, and the information that a certain object is in class/subset  $i$  (e.g. “class 5”) which applies with probability  $p_i$  to members of the set, then knowing it applies to an observation gives this many bits of info:

$$\text{Bits}(i) = -\sum_i p_i \log_2(p_i)$$

- That’s the number of bits of information in the label (or class)
- a residual is the number of bits left to enumerate/identify it completely
- Knowing something’s in a smaller category is “more” information
- Applied to whole classification systems: Information discrimination, Kullback-Leibler divergence, or relative entropy compares informativeness.
- It may be useful or necessary to compare patent classifications thus. (Or in my other work: occupation or industries.) Haven’t seen it done.
- More tricky I expect with patents classified in multiple tech classifications.

# Findings

- The 19<sup>th</sup> century patent classification systems are meaningfully different
  - I have no explanation for the specific differences
- They incorporate aeronautics by creating subclasses for it
  - Whether those make “sense” in the overall tree or not
  - Because splits and subsets are easy to make and search
  - They do not generally redesign their classifications
- They later harmonize everything in new IPC and CPC international standard systems