Cigarette company trade secrets are not secret: an analysis of reverse engineering reports in internal tobacco industry documents released as a result of litigation

Clayton Velicer,[1] Lauren K Lempert,[1] Stanton Glantz[1,2,3,4]

[1]Center for Tobacco Control Research and Education, University of California San Francisco, San Francisco, California, USA
[2]Philip R. Lee Institute for Health Policy Studies, University of California San Francisco, San Francisco, California, USA
[3]Helen Diller Family Comprehensive Cancer Center, University of California San Francisco, San Francisco, California, USA
[4]Department of Medicine, University of California San Francisco, San Francisco, California, USA

Correspondence to
Professor Stanton A Glantz, Center for Tobacco Control Research and Education, University of California San Francisco, 530 Parnassus, Suite 366, San Francisco, CA 94143-1390, USA; glantz@medicine.ucsf.edu

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ABSTRACT

Objectives Use previously secret tobacco industry documents to assess tobacco companies' routine claims of trade secret protection for information on cigarette ingredients, additives and construction made to regulatory agencies, as well as the companies' refusal to publicly disclose this information.

Methods We analysed previously secret tobacco industry documents available at (http://legacy.library.ucsf.edu) to identify 100 examples of seven major tobacco companies' reverse engineering of their competitors' brands between 1937 and 2001.

Results These reverse engineering reports contain detailed data for 142 different measurements for at least two companies, including physical parameters of the cigarettes, tobacco types, humectants, additives, flavourings, and smoke constituents of competitors' cigarettes. These 100 documents were distributed to 564 employees, including top managers in domestic and foreign offices across multiple departments, including executive leadership, research and design, product development, marketing and legal. These documents reported new competitors' products, measured ingredient changes over time, and informed companies' decisions regarding ingredients in their own products.

Conclusions Because cigarette companies routinely analyse their competitors' cigarettes in great detail, this information is neither secret nor commercially valuable and, thus, does not meet the legal definition of a 'trade secret.' This information is only being kept 'secret' from the people consuming cigarettes and the scientific community. Public agencies should release this detailed information because it would provide valuable information about how ingredients affect addictiveness and toxicity, and would help the public health community and consumers better understand the impact of cigarette design on human health.

INTRODUCTION

The ingredients and additives in tobacco products have important health implications. The type of tobacco affects carbon monoxide[1] (CO) and tobacco-specific nitrosamines[2] in smoke. Aceteldehyde, derived from burning sugars, enhances nicotine's addictive effect,[3] and is carcinogenic.[4] Additives including menthol, ammonia, propylene glycol, cocoa and licorice may modify nicotine's impact, cigarette toxicity, and make smoke seem less harsh and more pleasant.[5 6]

The USA,[7] 177 parties to the WHO Framework Convention on Tobacco Control[8 9] (FCTC) and 28 European Union member states[10] have committed to requiring tobacco manufacturers to disclose information about their products. Cigarette companies have refused to disclose by-brand ingredient information to the public or public agencies.[11] Since 2009, the US Food and Drug Administration (FDA) can require tobacco companies to submit ingredient information when applying for approval of new products or when claiming that one is 'substantially equivalent' to an existing product.[7] In 2013, when asked to provide documentation supporting its authorisation for the marketing of two new Lorillard cigarettes on the grounds that they were 'substantially equivalent' to existing products,[12] FDA responded with 197 pages of heavily redacted documents[13] that withheld cigarettes' physical parameters, ingredients and smoke constituents on the grounds that they were trade secrets.[13 14]

Far from being secret from the cigarette companies' competitors, tobacco industry documents reveal that all the major companies have detailed by-brand information about ingredients in competitors' cigarettes because they frequently and routinely reverse engineer each others' cigarettes. This fact raises questions about the companies' claims that information about their cigarettes' ingredients are entitled to trade secret protection because this information is widely known throughout the industry and, therefore, is neither secret nor commercially valuable (another criteria for being a trade secret). FDA and similar bodies elsewhere should make this information available to the public and the scientific community.

METHODS

We searched the UCSF Legacy Tobacco Documents Library (LTDL: http://legacy.library.ucsf.edu) reverse engineering using standard snowball techniques beginning with 'competitor brand analysis,' 'reverse engineering,' and 'competitor ingredients,' followed by competitors' brand names within individual company collections. Additional relevant documents were found by examining adjacent documents (Bates numbers) and searching individuals involved in reverse engineering studies. After identifying 100 reverse engineering reports (see online supplementary excel file E-1) and 61 letters discussing reverse engineering projects (see online supplementary excel file E-2), we stopped collecting documents.

RESULTS

The examples of reverse engineering and associated correspondence came from American Tobacco, British American Tobacco (BAT), Brown and Williamson (B&W), Liggett and Myers, Lorillard, Philip Morris (PM), and RJ Reynolds (RJR) between 1937 and 2001. These reports were circulated to many high-level employees in multiple departments within the companies; 564 people were authors or recipients (table 1).

These 100 reverse engineering studies include 142 measurements of the cigarette, its constituents, or the smoke that were measured by at least two companies (table 2 and see online supplementary file E-1). The most common measurements (in at least 20/100 reports) were: expanded tobacco, reconstituted tobacco, glycerine, propylene glycol, CO, nitrates, nicotine, phosphates, tar, ammonia, cocoa, licorice, menthol and sugars. The companies used a variety of techniques to analyse competitors' products, including simple physical measurements (length and circumference), cutting cigarettes open, separating tobacco types under a microscope and weighing them,[15 16] placing tobacco in liquid nitrogen to determine the amount of puffed tobacco,[17] to advanced technologies, including X-ray fluorescence,[18] infrared and mass spectrometry,[19] gas chromatography[20] and thermogravimetric analysis.[21]

Frequency

The companies routinely reverse engineered competitors' products and detected how they changed over time. For example, American Tobacco tracked Lorillard's blends quarterly,[22] B&W measured sugar and alkaloids in PM's Marlboro King Size annually between 1976 and 1989, and urea beginning in 1986,[23] RJR's 'Competitive Audit Program' completed detailed analyses of up to 20 competitors' brands monthly, including a 1994 report that listed 20 analyses performed monthly, including physical analysis, smoke menthol, amount of reconstituted tobacco, and measurements for glycerine, sugars, reducing sugars and nicotine.[24]

Reverse engineering new products

The companies analysed new products as competitors introduced them.[25–31] Two examples illustrate the depth of this reverse engineering.

Eclipse

In 1996, RJR test marketed Eclipse, a product that delivered nicotine by heating, rather than burning, tobacco that claimed to produce nearly 90% less secondhand smoke.[32] (A 2002 independent analysis of Eclipse found that it was as or more toxic than an ultralight cigarette.[33]) B&W measured three kinds of reconstituted tobacco in Eclipse, and the percentages of phosphate, nitrate, chloride, glucose, and fructose.[30] Lorillard's 1997 Progress Report #7 on Eclipse Cigarettes Smoking Lab Analysis and Determination of Phenols in Mainstream Smoke concluded that Eclipse had lower levels of phenolic compounds per milligram of dry particulate matter per cigarette than B&W's Carlton.[34] (Phenolic compounds are cardiovascular toxins.[35]) A second 1997 Lorillard report added data on propylene glycol, glycerol, menthol, formaldehyde, acetaldehyde, acrolein and propional in four Eclipse varieties.[36]

Winston Natural

In 1995, RJR introduced Winston Natural as a 100% additive-free cigarette.[37] PM reported 43 measurements of physical data on the cigarette, filter components, type of tobacco used and Federal Trade Commission measurements[25] (nicotine, tar and CO). B&W detected no humectants (propylene glycol or glycerine) and concluded that the reconstituted tobacco was a 'special one' because it had lower levels of sugar than the reconstituted tobacco RJR used in Winston full flavour and light regulars. The authors concluded that 'Winston NA seems to truly be a product with no additives.'[28] Lorillard measured the amount of humectants (propylene glycol, glycerine or triacetin) and theombromine, and concluded there were 'insignificant levels of additives.'[26]

Case studies

These six case studies describing work by five tobacco companies provide a more detailed picture of the depth of the data the companies' developed through reverse engineering competitors' products. Case Study 1, a 1970 American Tobacco report,[38] exemplifies a very detailed analysis that includes 189 measurements of each brand, and that the information was provided to high-level executives. Case Study 2, a 1975 Liggett report on competitors' brands and subsequent research,[39 40] shows how reverse engineering a competitor's products led to changes in the company's own products. Case Study 3, a 1992 B&W report,[41] shows the international scope of reverse engineering. Case Study 4, a 1986 B&W report,[42] provides another example of how data obtained from reverse engineering products led to suggested changes in a company's own products. Case study 5, a 2001 PM report,[31] demonstrates the depth analysis of competitors' new products. Case Study 6, a 1991 RJR report,[43] illustrates the breadth of reverse engineering competitor's products domestically, with monthly analysis of cigarettes collected in four cities to determine consistency of ingredients and physical parameters.

Case Study 1: 1970 American Tobacco's report on multiple competitor brands

American Tobacco's Managing Director of Research and Development and Manager of the New Products Division (part

Table 1 Tobacco company employees that authored or received reverse engineering reports

Department	American Tobacco	Brown & Williamson and BAT*	Liggett & Myers	Lorillard	RJ Reynolds	Philip Morris
Top management†	x	x	x	x	X	x
Research and design	x	x	x	x	X	x
Product development	x	x		x	X	x
Sales, marketing, or business	x	x	x	x	X	x
Legal		x	x		X	x
international†‡	x	x			X	x

*Four British American Tobacco (BAT) reverse engineering documents are included with the Brown & Williamson documents; Brown & Williamson was BAT's US subsidiary at the time.
†President, CEO, or vice-president.
‡Report was received by an employee in a foreign subsidiary or office.

Table 2 Summary of 100 reports reverse engineering competitors' products*

Measurements	American Tobacco	B&W and BAT	Liggett	Lorillard	RJ Reynolds	PM
Number of reports	7	28	5	9	32	19
Dates	(1937–1983)	(1969–1997)	(1974–1991)	(1975–1998)	(1962–1997)	(1965–2001)
Physical parameters of cigarette						
Ash %	x	x		x	x	
Average weight or cigarette weight	x	x	x	x	x	x
Burning rate	x	x	x		x	x
Butt length					x	x
Cigarette length	x	x	x	x	x	x
Circumference	x	x	x	x	x	x
Citrate	x	x		x	x	x
Dry particulate matter	x			x	x	x
Dry tobacco burned	x	x				
Filling capacity\ratio\power	x		x		x	
Filter efficiency		x		x		x
Filter length	x	x	x	x	x	x
Filter type	x	x	x	x	x	x
Filter ventilation		x	x			x
Filter weight		x	x	x	x	x
Firmness	x	x		x	x	x
Loose ends					x	x
Moisture	x	x		x	x	
Moisture equilibrium	x		x			
Oven volatiles %					x	x
Paper porosity	x	x	x	x	x	x
Paper type	x			x		x
Permeability		x				x
Pressure drop filter	x	x	x	x		
Pressure drop of cigarette	x	x	x	x	x	
Pressure drop tobacco column	x	x				
Puffs	x	x	x	x	x	x
Sieve analysis	x				x	
Strand width		x			x	
TEGD					x	x
Tipping length	x	x	x	x	x	x
Tipping paper type	x			x		x
Tobacco density	x	x		x	x	x
Tobacco rod length		x			x	x
Tobacco rod weight	x	x	x	x	x	x
Total particulate matter		x			x	x
Triacetin	x	x			x	x
Type of perforations	x					x
Ventilation %	x	x	x	x	x	x
Wet particulate matter	x				x	x
Width of cut	x			x		x
Smoke constituents						
Acetaldehyde	x	x		x	x	x
Acetone	x				x	x
Acrolein	x	x		x	x	x
Aldehydes	x	x	x			
Ammonia in smoke		x			x	x
Benzene		x			x	
Carbon monoxide	x	x	x	x	x	x
Ethane		x				x
Formaldehyde		x		x	x	x
Furan	x				x	x
Hydrogen cyanide	x	x	x		x	x
Isoprene	x	x			x	x
Menthol in smoke		x	x		x	x
Methane		x				x

Continued

Table 2 Continued

Measurements	American Tobacco	B&W and BAT	Liggett	Lorillard	RJ Reynolds	PM
Number of reports	7	28	5	9	32	19
Dates	(1937–1983)	(1969–1997)	(1974–1991)	(1975–1998)	(1962–1997)	(1965–2001)
Methanol	x				x	x
Methyl acetate	x					x
Methyl chloride		x				x
Methyl furan	x					x
NAT	x	x			x	
Nicotine in smoke	x	x	x	x	x	x
Nitrogen oxides	x	x			x	x
NNK	x	x	x		x	
NNN	x	x	x		x	
pH	x	x			x	x
Phenol	x				x	
Propionaldehyde	x				x	
Tar in smoke	x	x			x	x
Toluene		x			x	x
Types of tobacco						
Band cast recon	x	x				
Bright	x		x			
Burley	x	x	x		x	
Dark recon		x			x	
Expanded stems	x		x			x
Flue cured		x			x	
Lamina		x				x
Light recon		x			x	
Oriental		x				
Paper cast recon	x	x				
Processed stems	x	x				
Puffed tobacco/expanded	x	x		x	x	x
Reconstituted tobacco	x	x	x		x	x
Rolled stems	x	x				
Stem	x	x	x		x	x
Turkish	x		x		x	
Chemicals, flavourings and additives						
Alkaloids		x			x	x
Amino nitrogen		x	x			
Ammonia	x	x	x	x	x	x
Ammonia nitrogen		x				x
Anatabine		x			x	
β-D-glucose		x				
B-methylvaleric		x				x
Calcium	x			x	x	
Chloride	x	x		x	x	
Chlorogenic acid		x			x	
Citric acid	x	x		x	x	
Cocoa/theobromine	x	x		x	x	x
Cotinine		x			x	
Coumarin	x		x		x	x
Formic acid	x	x		x	x	
Fructose	x	x	x	x	x	x
Glucose	x	x	x	x	x	x
Glycerine	x	x	x	x	x	x
Glycyrrhizen	x				x	
Glycyrrhzic acid		x			x	x
Iso-butyric acid (Volatile acid)		x			x	
Iso-valeric (volatile acid)		x			x	
Licorice	x	x			x	x
Magnesium	x			x	x	
Malic acid	x	x		x	x	

Continued

Table 2 Continued

Measurements	American Tobacco	B&W and BAT	Liggett	Lorillard	RJ Reynolds	PM
Number of reports	7	28	5	9	32	19
Dates	(1937–1983)	(1969–1997)	(1974–1991)	(1975–1998)	(1962–1997)	(1965–2001)
Maltose		x	x	x	x	
Manganese				x	x	
Menthol	x	x	x	x	x	x
Nicotine in tobacco	x	x	x	x	x	x
Nitrates		x	x	x	x	x
Nornicotine		x			x	
Oxalic acid	x			x	x	
Palmitic acid		x			x	
Phosphate	x	x			x	
Phosphorous				x		x
Potassium	x	x		x	x	
Propionic (volatile acid)		x			x	
Protein nitrogen as NH3	x	x				
Pyrazine		x			x	
Reducing sugars		x		x	x	x
Sodium	x	x		x	x	
Sorbitol		x			x	
Sucrose	x	x	x	x	x	x
Sugars	x	x	x	x	x	x
Sulfate		x			x	
Total nitrogen		x	x	x	x	
Total volatile acids as acetic	x	x			x	
Total volatile bases	x	x		x		
Total volatile bases as ammonia	x				x	
Vanillin	x				x	x
Vapour-phase analysis	x	x			x	
Urea		x			x	
Water		x	x		x	x
Humectants						
Glycerine	x	x	x	x	x	x
Propylene glycol)	x	x	x	x	x	x
Total humectants	x	x			x	
Triacetin	x	x			x	x
Triethylene glycol	x		x		x	

*For details of individual reports, see supplementary Excel file E-1.
BAT, British American Tobacco; NAT, N′-nitrosoanatabine; NNK, nicotine-derived nitrosamine ketone [4-(methylnitro-samino)-1-(3-pyridyl)-1-butanone]; NNN, N′-nitrosonornicotine; PM, Philip Morris; RJR, RJ Reynolds; TEGD, triacetic and triethlyne glycol di-acetate (a component of cigarette filters).; TVB, total volatile bases.

of Research and Development) sent a report to the President and Chief Executive Officer[38] detailing their comprehensive analysis of Winston (RJR) and Marlboro (PM), Kent (Lorillard), L&M (Liggett), Viceroy (B&W), and Kool (B&W) cigarettes, including comparisons with American Tobacco's brands (Silva Thins, Pall Mall Filter, and Tareyton). The 199 measurements for each brand included:

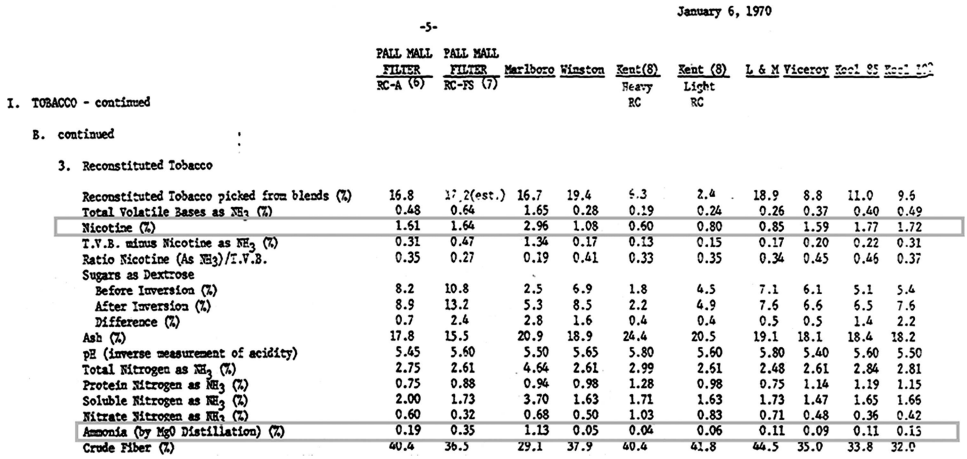
- tobacco types (6) (Turkish, Maryland, Burley, Bright, reconstituted tobacco and rolled stems)
- chemicals (48) in the tobacco blends
- chemicals (29) in the reconstituted tobacco
- flavourings (6) and additives
- humectants (3)
- physical parameters (38)
- smoke compounds (69)

The report also included a summary for each brand that compared competitors' products to each other and discussed how findings from other products helped American Tobacco better understand the impact of the ingredients in its own products. The report concluded that the higher nicotine content in the Marlboro reconstituted tobacco represented nicotine migration from the rest of the tobacco blend because of the presence of ammonia salts. (American Tobacco had previously found increased nicotine in their own reconstituted tobacco blends.[38]) By comparing products from multiple competitors (figure 1), American Tobacco recognised the relationship between ammonia salt content and nicotine level in reconstituted tobacco, and learned that ammonia salt-induced nicotine migration from the rest of the tobacco blend results in higher nicotine levels in reconstituted tobacco than without added ammonia.

Case Study 2: Liggett and Myers 1975 report on Marlboro Light 85

This report[39] contained data on the physical parameters of 12 brands: Marlboro and Marlboro Light (PM), Winston and Winston Lights (RJR), Viceroy and Viceroy Milds and Kool and Kool Milds (B&W), Kent and Kent Golden Lights (Lorillard), and Pall Mall and Pall Mall extra mild (American Tobacco), and discussed how the ventilated filter system Marlboro and several competitors used impacted CO yields:

Figure 1 Chemical breakdown of reconstituted tobacco from selected competitor products in an American Tobacco 1970 report[38] comparing several of its brands with competitors' brands. The highlighted section shows the large differences in ammonia and nicotine in Marlboro's reconstituted tobacco compared to competitors' products. This information led American Tobacco to hypothesise that the use of ammonia salt in reconstituted tobacco can cause nicotine to migrate from the rest of the blend.



January 6, 1970

-5-

I. TOBACCO - continued

B. continued

3. Reconstituted Tobacco

	PALL MALL FILTER RC-A (6)	PALL MALL FILTER RC-FS (7)	Marlboro	Winston	Kent(8) Heavy RC	Kent (8) Light RC	L & M	Viceroy	Kool 85	Kool 100
Reconstituted Tobacco picked from blends (%)	16.8	17.2(est.)	16.7	19.4	6.3	2.4	18.9	8.8	11.0	9.6
Total Volatile Bases as NH_3 (%)	0.48	0.64	1.65	0.28	0.19	0.24	0.26	0.37	0.40	0.49
Nicotine (%)	1.61	1.64	2.96	1.08	0.60	0.80	0.85	1.59	1.77	1.72
T.V.B. minus Nicotine as NH_3 (%)	0.31	0.47	1.34	0.17	0.13	0.15	0.17	0.20	0.22	0.31
Ratio Nicotine (As NH_3)/T.V.B.	0.35	0.27	0.19	0.41	0.33	0.35	0.34	0.45	0.46	0.37
Sugars as Dextrose										
Before Inversion (%)	8.2	10.8	2.5	6.9	1.8	4.5	7.1	6.1	5.1	5.4
After Inversion (%)	8.9	13.2	5.3	8.5	2.2	4.9	7.6	6.6	6.5	7.6
Difference (%)	0.7	2.4	2.8	1.6	0.4	0.4	0.5	0.5	1.4	2.2
Ash (%)	17.8	15.5	20.9	18.9	24.4	20.5	19.1	18.1	18.4	18.2
pH (inverse measurement of acidity)	5.45	5.60	5.50	5.65	5.80	5.60	5.80	5.40	5.60	5.50
Total Nitrogen as NH_3 (%)	2.75	2.61	4.64	2.61	2.99	2.61	2.48	2.61	2.84	2.81
Protein Nitrogen as NH_3 (%)	0.75	0.88	0.94	0.98	1.28	0.98	0.75	1.14	1.19	1.15
Soluble Nitrogen as NH_3 (%)	2.00	1.73	3.70	1.63	1.71	1.63	1.73	1.47	1.65	1.66
Nitrate Nitrogen as NH_3 (%)	0.60	0.32	0.68	0.50	1.03	0.83	0.71	0.48	0.36	0.42
Ammonia (by MgO Distillation) (%)	0.19	0.35	1.13	0.05	0.04	0.06	0.11	0.09	0.11	0.13
Crude Fiber (%)	40.4	36.5	29.1	37.9	40.4	41.8	44.5	35.0	33.8	32.0

> The filter [used by Marlboro] reduces all gas phase yields, which the other approaches do not, and it reduces CO in particular, which no other filter does. Thus, when, sooner or later, the CO yield of cigarettes is officially monitored and published, the ventilated filters have the advantage of being low in CO as well as 'tar' and nicotine.[39]

This example reveals how reverse engineering allowed companies to better prepare their products for potential changes in tobacco legislation, such as a requirement to disclose brand CO yields.

The report also found that Marlboro Lights 85 and Marlboro 85 contained much higher ammonia than the Liggett's L&M 85 cigarettes[39] (figure 2). A subsequent 1976 report by the same Liggett scientist, Development of a Cigarette with An Increase Smoke pH,[40] suggested how this information may have been used. After finding that Marlboro brands had much higher ammonia levels, Liggett tested the pH level of its Lark brand after restuffing it with tobacco treated with two different levels of ammonia-based compounds and found that doing so increased smoke pH of low-yield Larks.[40] Adding ammonia increases smoke pH and increases cigarettes' nicotine delivery and addictiveness.[5]

Case Study 3: Brown and Williamson 1992 analysis of seven domestic Marlboro brands

PM's Global Strategy Marlboro Product Technology[41] compares 11 cigarette ingredients in Marlboro King Size—including glycerine, cocoa, licorice, fructose, sucrose and glucose—to ingredients in RJR's Winston and B&W's Richland/Viceroy, as well as cigarettes sold in other countries (figure 3). B&W's manager of Project Planning in Research and Development distributed the report to high-level managers and others at B&W and other BAT subsidiaries around the world.[41]

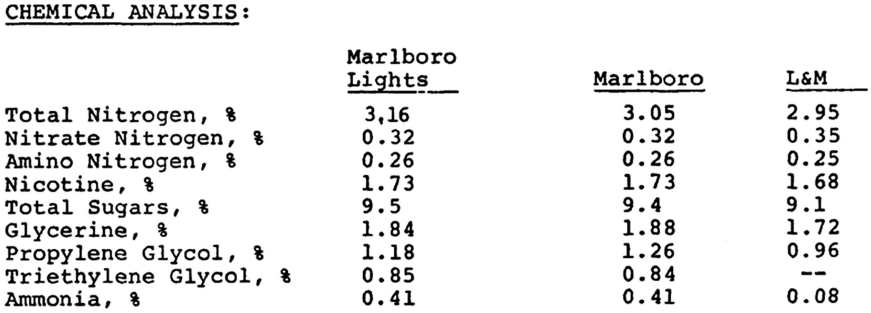
The report noted that B&W was monitoring Marlboro over time: 'In this review we continue to assess the Marlboro technology in total and in the individual blend components. With this knowledge, we have then weighted the various factors which contribute to the distinctive Marlboro character.'[41] It also reports specific product differences between countries. For example, 'in markets such as Australia, Brazil and Argentina where economic and financial issues could be impacted by the use of reconstituted tobacco, PM has not introduced this technology.'[41] This information was particularly useful to BAT's Brazil subsidiary Souza Cruz, because it informed them that PM products in Brazil did not include reconstituted tobacco, but rather used stem treated with ammonia, suggesting a way that BAT could alter their products in Brazil.[41]

Case Study 4: 1986 Brown and Williamson key brands analysis for reverse engineering

This report was distributed to 16 B&W employees, including the director of the Product Development Department, and contains data on tobacco blends used in the menthol and non-menthol versions of Lorillard and RJR cigarettes, including the amount of reconstituted, expanded tobacco, and stem by brand.[42] It also compares eight measurements (propylene glycol, glycerine, cocoa, licorice, lactate sucrose, moisture and water) of B&W products with Lorillard and RJR products, including how information from previous reports had been used to improve B&W products:

> Thus, early in 1985 we already had a large body of analytical data on key competition brands, and were using this information in product development. Some of these advances were incorporated into improved versions of some key B&W brands in mid-1985.[42]

Figure 2 This comparison of the chemicals in the blends of brands from Marlboro and Liggett and Myers in a 1975 Liggett report demonstrates that Marlboro brands studied had more than five times the percent of ammonia as the Liggett brand[39] (L&M).



CHEMICAL ANALYSIS:

	Marlboro Lights	Marlboro	L&M
Total Nitrogen, %	3.16	3.05	2.95
Nitrate Nitrogen, %	0.32	0.32	0.35
Amino Nitrogen, %	0.26	0.26	0.25
Nicotine, %	1.73	1.73	1.68
Total Sugars, %	9.5	9.4	9.1
Glycerine, %	1.84	1.88	1.72
Propylene Glycol, %	1.18	1.26	0.96
Triethylene Glycol, %	0.85	0.84	--
Ammonia, %	0.41	0.41	0.08

Figure 3 Ingredients in the tobacco blends of Marlboro King Size across eight countries, Europe and the USA, with comparisons to RJ Reynolds' brand Winston and B&W's brand Richland/Viceroy presented in a B&W report on competitors' brands across markets.[41]

World-Wide Marlboro KS and Comparison Products
Casing Chemistry

	% PG	% Glycerine	Ratio Glycerine/PG	% Total Sugars	% Reducing Sugars	Ratio Reducing/ Total Sugars	% Cocoa	% Licorice	% Glucose	% Fructose	% Sucrose
U.S.A.	1.9	2.3	1.21	12.0	9.2	0.77	0.5	0.8	2.3	2.9	3.2
U.S.A. Export	1.7	2.2	1.29	11.8	8.1	0.69	0.5	0.7	2.7	3.7	2.5
Euro-Average	1.6	2.2	1.31	13.8	9.2	0.67	0.4	1.2	3.2	3.7	3.7
Venezuela	1.1	1.4	1.27	12.7	8.9	0.70	0.4	1.0			
Germany	1.6	2.1	1.31	14.5	10.1	0.70	0.4	1.5	4.2	4.2	3.8
Malaysia - New	1.0	1.3	1.30	8.4	7.0	0.83	0.2	0.2			
Panama	1.4	1.9	1.36	10.9	6.2	0.57	0.6	0.8			
Japan	1.9	1.7	0.89	12.6	7.6	0.60	0.7	0.8	3.6	4.4	3.0
Brazil	0.7	1.0	1.43	7.8	7.0	0.90	0.6	1.0			
Argentina	2.5	0.0	0.00	14.2	9.0	0.63					
Australia	0.7	1.0	1.43	13.0	9.3	0.72	0.4	0.9	3.4	4.3	3.3
Winston (U.S.A.)	0.6	2.2	3.67	9.3	7.8	0.83	0.6	1.0	2.2	2.8	0.0
RICHLAND/VICEROY (B&W)	1.5	1.8	1.20	11.8	7.9	0.67	0.4	1.3	1.1	2.2	2.1

The report used the updated data to suggest nine changes to make B&W Kool more like competitor brands (figure 4), including changes to the tobacco (such as reconstituting all the stem used and doubling the amount of expanded tobacco), changes to the ingredients (such as using 25% less glycerine and using 1% cocoa and 0.6% licorice), and changes to the physical parameters (increasing ventilation).

Case Study 5: PM analysis of five new RJR products

A 2001 interoffice memo reviewed five new RJR products (Winston S2, advertised as 'quantum smooth' and marketed in a silver metallic pack, and four new exotic flavours, Camel Turkish Jade, Camel Turkish Jade Light, Camel Mandarin Mint and Camel Dark Mint) was distributed to 46 employees including the vice president of Worldwide Scientific Affairs, and the senior vice president of Research Design and Engineering.[31] Forty measurements were provided for each brand, including physical parameters, amount of expanded tobacco, reconstituted tobacco, menthol and smoke constituents.

PM investigated its competitors' marketing claims as new products were introduced. The same letter summarised analyses done on the tobacco-specific nitrosamine (TSNA) levels of the Star Scientific brand Gsmoke in response to claims by the Starbrand's CEO that the brand contained 'approximately 24% low-TSNA Star-cured tobacco'[31] as of April, 2001. In contrast with this claim, PM found that TSNA levels in Gsmoke smoke in June 2001 were similar to February 2000.[31] PM noted, however, that the sample tested in June 2001 may not have been recently produced, so additional samples of Gsmoke would be analysed and reported as they became available.

TO MAKE KOOLS MORE LIKE NEWPORTS:

Reconstitute All Stem	Reduce Menthol
Puff An All-Virginia Blend	Add ca. 0.75% Lactic Acid
Increase ET Level	Use Licorice In Casings
Reduce Pressure Drop	Eliminate Sucrose In Casings
Reduce Density	Small Reduction In Glycerin

TO MAKE KOOLS MORE LIKE SALEMS:

Reconstitute All Stem	Eliminate Sucrose in Casings
Puff A Cased Burley Blend	Use 25% Less Glycerin
Double The ET Level	Use 1% Cocoa and 0.6% Licorice
Use Less F-C, More Oriental	Increase Ventilation
	Increase Pressure Drop

Figure 4 Changes that can be made to Brown & Williamson brand, Kool, to improve it by making it like products made by Lorillard and RJ Reynolds, from the 1985 Brown & Williamson report.[42] ET, Expanded Tobacco; F-C, Flue cured.

Case Study 6: RJR' analysis of competitor brands from four cities

This 1991 report, distributed to 43 employees, contained data on 22 brands purchased monthly in Atlanta, Cleveland, Richmond and Columbia, South Carolina in January–June 1990.[43] It reported monthly mean and SDs for 18 physical and 13 measurements of chemicals in the cigarette, which allowed RJR to compare changes in the products. The report concluded RJR had an advantage over its competitors because its products had less variation in physical parameters over time, but a disadvantage because RJR products had more nicotine variation than its competitors' brands.

DISCUSSION

The 100 documents dating back to 1937 establish that all the major tobacco companies routinely reverse engineer their competitors' products on a by-brand basis. This information was distributed widely within each company, including among top management, marketing, product development and research departments around the world (table 1) and used to suggest changes in the companies' own products. This evidence contradicts the companies' claims that the ingredients in their products are, in fact, 'secret' from each other and deserve to be protected by trade secret law.

Ingredients information does not meet the legal definition of trade secret

While there is no one definition of 'trade secret,' the general rule from common law and codifications of the Uniform Trade Secrets Act (UTSA, a model state law[44 45]) is that a trade secret is any information that benefits a business commercially and is kept secret.[45–48] Before the UTSA, improper use or disclosure of trade secrets were usually handled as common law torts, with many courts adopting the definition of 'trade secret' in the *Restatement of Torts*:

> A trade secret may consist of any formula, pattern, device or compilation of information which is used in one's business, and which gives him an opportunity to obtain an advantage over competitors who do not know or use it. It may be a formula for

> a chemical compound, a process of manufacturing, treating or preserving materials, a pattern for a machine or other device, or a list of customers.[47]

As of May 2014, all but two states had adopted some version of the UTSA[45] that defines trade secret:

> 'Trade secret' means information, including a formula, pattern, compilation, program, device, method, technique, or process, that:
>
> (i) derives independent economic value, actual or potential, from not being generally known to, and not being readily ascertainable by proper means by, other persons who can obtain economic value from its disclosure or use, and
> (ii) is the subject of efforts that are reasonable under the circumstances to maintain its secrecy.[45] [emphasis added]

Matters of public or general knowledge in an industry are not trade secrets, nor are matters that can be gleaned by examining a product sold on the open market; rather, 'a trade secret is known only in the particular business in which it is used.'[47] Courts determine whether business information deserves trade secret protection on a case-by-case basis, typically considering:

1. The extent to which the information is known outside the claimant's business.
2. The extent to which it is known by employees and others involved in the business.
3. The extent of measures taken by the claimant to guard the secrecy of the information.
4. The value of the information to the business and its competitors.
5. The amount of effort or money expended by the business in developing the information.
6. The ease or difficulty with which the information could be properly acquired or duplicated by others.[47]

Applying these criteria to the evidence presented in this paper suggests that the companies are not entitled to trade secret protection for information about their cigarettes' ingredients:

1. The ingredients information is widely known outside each company's business. (For example, Case Study 2 shows that Liggett and Myers acquired detailed measurements on parameters and ingredients of PM, RJR, B&W, Lorillard and American Tobacco products).
2. The information has been distributed to and known by hundreds of employees in multiple domestic and international departments at each company.
3. The companies did not, and could not, take measures to guard the secrecy of information about their cigarettes' physical parameters (such as length and circumference of cigarette rods and filters) and basic ingredients information (such as type of tobacco and other additives), since their cigarettes were sold and available on the open market, and any consumer (or company) could buy cigarettes produced by competitors and legally measure these features.
4. Information that is widely known by every company within a particular industry has little or no commercial value to any one company. (For example, if every soft drink manufacturer knew the Coke formula, that formula would no longer be valuable to Coca Cola Company).
5. All the major tobacco companies have had the ability (some since at least 1937) to routinely conduct reverse-engineering activities, so these appear to be within the normal course of business.
6. Information about the physical parameters of competitors' cigarettes (such as length and circumference of cigarette rod and filters) could be easily acquired by purchasing the cigarettes and measuring these dimensions. Information about ingredients and additives used in competitors' cigarettes is more difficult to obtain, but all major tobacco companies routinely and properly acquire this information by purchasing competitors' cigarettes and subjecting them to simple and complex analyses.

The US Supreme Court defined 'reverse engineering' as 'starting with the known product and working backward to divine the process which aided in its manufacture',[49] and has consistently held that products or ideas that have been placed on the open market may be lawfully copied or reverse-engineered and are not protected by trade secret laws.[49 50] Indeed, in 1989, the Court characterised reverse engineering as 'an essential part of innovation,' likely to yield variations on the product that 'could lead to significant advances in technology' and 'the competitive reality of reverse engineering may act as a spur to the inventor.'[50]

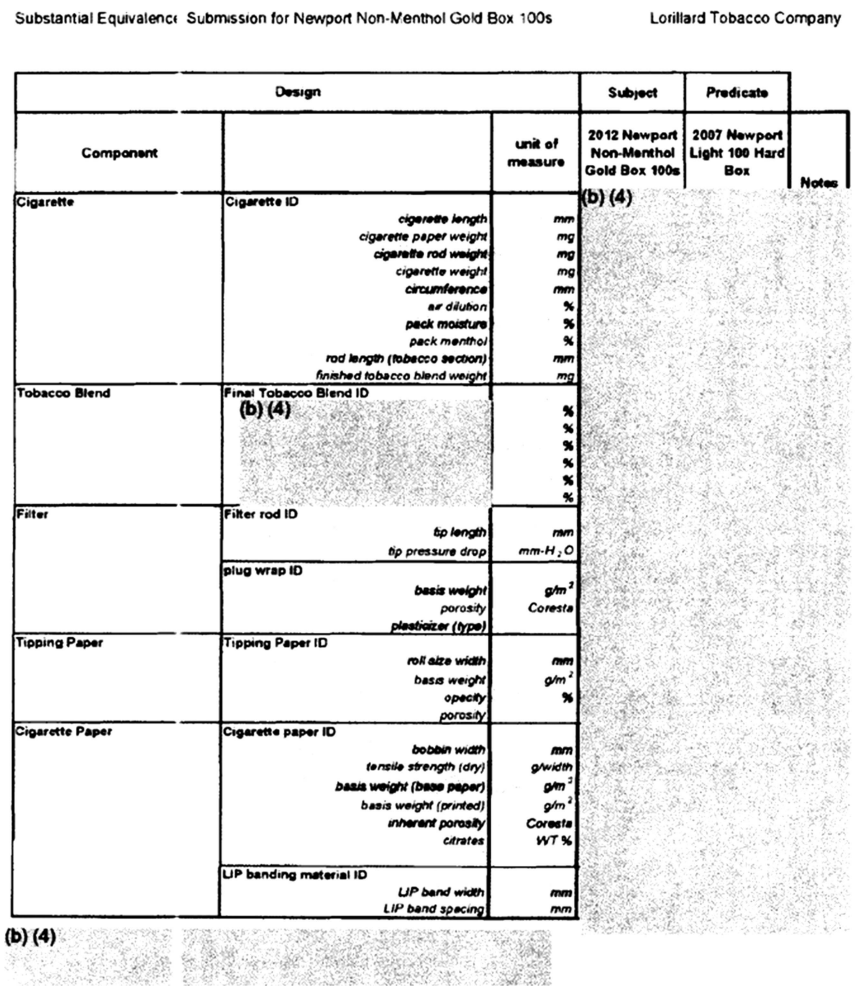
The reports summarised in this paper demonstrate that tobacco companies lawfully acquired each others' products by purchasing them on the open market and routinely reverse engineered them. It is a well settled legal principle that a business is not entitled to trade secret protection for information that is widely known outside of that business.[45 47]

While our examples are from 1937 to 2001, it is reasonable to assume that tobacco companies have continued their reverse engineering activities as new products continue to appear in the open market, and that the industry's capacity to reverse engineer is at least as good as in the past. Information about a particular tobacco company's cigarette ingredients that was acquired through reverse engineering is not secret, does not confer commercial value to that company, and is not entitled to trade secret protection.[47 49 50]

Implications for how the FDA (and similar authorities in other states and countries) treats tobacco company assertions of trade secret

The Family Smoking Prevention and Tobacco Control Act (FSPTCA) gives the FDA authority over tobacco products, and requires tobacco companies to submit ingredients information when applying for approval of new products.[7] Similar regulations have been enacted in other countries.

FDA's regulatory scheme requires manufacturers to submit detailed information about tobacco product ingredients in several circumstances. Within 2 months of FSPTCA enactment, all tobacco product manufacturers were required to submit to FDA information on all ingredients in their products, 'including tobacco, substances, compounds, and additives that are … added by the manufacturer to the tobacco, paper, filter, or other part of each tobacco product by brand and by quantity in each brand and subbrand.'[51] Manufacturers were also required to submit specific nicotine information 'measured in milligrams of nicotine.'[52] Additionally, beginning 3 years after enactment of FSPTCA (by 22 June 2012), manufacturers must submit a listing of 'all constituents, including smoke constituents' that have been identified by FDA as 'harmful or potentially harmful to health … by brand and by quantity in each brand and subbrand.'[53] Manufacturers must supplement these lists of ingredients by submitting research on the 'health, toxicological, behavioural, or physiologic effects of current or future tobacco products, their constituents (including smoke constituents), ingredients, components, and additives', and research on 'harmful and potentially harmful constituents, including smoke constituents … in each tobacco product by brand and by quantity in each brand and subbrand.'[54] Tobacco companies



Substantial Equivalence Submission for Newport Non-Menthol Gold Box 100s — Lorillard Tobacco Company

Design			Subject	Predicate	
Component		unit of measure	2012 Newport Non-Menthol Gold Box 100s	2007 Newport Light 100 Hard Box	Notes
Cigarette	Cigarette ID		(b) (4)		
	cigarette length	mm			
	cigarette paper weight	mg			
	cigarette rod weight	mg			
	cigarette weight	mg			
	circumference	mm			
	air dilution	%			
	pack moisture	%			
	pack menthol	%			
	rod length (tobacco section)	mm			
	finished tobacco blend weight	mg			
Tobacco Blend	Final Tobacco Blend ID				
	(b) (4)	%			
		%			
		%			
		%			
		%			
		%			
Filter	Filter rod ID				
	tip length	mm			
	tip pressure drop	mm-H_2O			
	plug wrap ID				
	basis weight	g/m^2			
	porosity	Coresta			
	plasticizer (type)				
Tipping Paper	Tipping Paper ID				
	roll size width	mm			
	basis weight	g/m^2			
	opacity	%			
	porosity				
Cigarette Paper	Cigarette paper ID				
	bobbin width	mm			
	tensile strength (dry)	g/width			
	basis weight (base paper)	g/m^2			
	basis weight (printed)	g/m^2			
	inherent porosity	Coresta			
	citrates	WT %			
	LIP banding material ID				
	LIP band width	mm			
	LIP band spacing	mm			

(b) (4)

Figure 5 An example of measurements redacted by Food and Drug Administration (FDA) based on Lorillard's trade secret claims, acquired through a Freedom of Information Act (FOIA) request made to FDA on 8 July 2013[12] for documents concerning Lorillard's Substantial Equivalence Submission on 12 October 2011 for Newport Non-Menthol Gold Box 100s.[13]

must submit detailed information about the ingredients and smoke constituents of the new product, and, for substantial equivalence applications, of the predicate product.[55] Manufacturers must also submit detailed information to FDA if at any time they add a new additive or increase the quantity of an existing tobacco additive to an existing product.[56]

Likewise, the FCTC includes provisions regulating the contents and emissions of tobacco products, requires that ingredients be disclosed,[8 9] and encourages parties to go beyond these minimum standards.[57] The March 2014 revision to the EU Tobacco Product Directive (TPD) includes compulsory reporting of the ingredients used in tobacco products,[10] including all ingredients used in the manufacture of cigarettes and emission levels, along with internal and external studies on market research and preferences of consumers relating to ingredients and emissions by brand name and type. The TPD requires that this information be made publicly available. To enable member states to protect trade secrets when making that information publicly available, manufacturers must specify what they consider trade secrets when they submit this ingredient information.[10] Our results suggest that EU member states should carefully evaluate any such assertions of trade secrets since much of the information the manufacturers' submit may not, in fact, be trade secrets.

US law requires FDA to disclose all or part of the ingredients information submitted to it by manufacturers. The FSPTCA explicitly requires FDA to publish a list that is 'understandable and not misleading to a lay person of harmful and potentially harmful constituents, including smoke constituents, in each tobacco product by brand and by quantity in each brand and subbrand' (Section 904(d)(1)).[58] Moreover, to further FDA's public health mandate, FDA's transparency policy and the US Freedom of Information Act (FOIA) both underscore the importance of disclosing information to the public if it is not specifically exempted from disclosure by FOIA.[14 59] However, FDA has interpreted FOIA's (b)(4) trade secret exemption so broadly that it effectively makes public disclosure meaningless (figure 5) and makes it impossible to determine the scientific standards FDA used to make the substantial equivalence determination.

Although we reviewed only 100 cigarette company reverse engineering reports for this study, we found significant overlap between the measurements FDA labelled as 'trade secrets' and the measurements we found in the tobacco companies' reverse engineering reports. Lorillard's substantial equivalence application included 37 physical measurements FDA redacted based on trade secret claims[13]; 24 of these 37 measurements, including simple measurements such as cigarette length, cigarette weight, circumference and filter weight, were determined routinely by tobacco companies in the course of reverse engineering their competitors' products (table 2 and see online supplementary file E-1). Since these measurements were regularly included in reports from 1937 to 2001 and could be ascertained with tools as simple as scales or rulers, they cannot be protected as trade

secrets. FDA also redacted 14 smoke constituent measures on trade secret grounds, eight of which (nicotine, tar, carbon monoxide, acrolein, formaldehyde, benzene, acetaldehyde and N′-nitrosonornicotine [NNN]) appear in tobacco companies' reverse engineering reports. These constituents have been routinely measured by manufacturers when examining competitors' products, and have significant impacts on cigarette smoke toxicity.

Information companies acquire through reverse engineering their competitors' products most likely reveals the same results as information companies acquire by testing their own products. While it may be argued that the tobacco manufacturers can more accurately measure specific ingredients in their own products than their competitors' products, they have acknowledged that many measurements can be accurately taken for competitor brands. In 2000, scientists from (competitors) B&W, Lorillard, RJR and PM worked together to release a report to the Massachusetts Department of Public Health containing the amounts of 43 constituents in mainstream smoke and physical measurements, filter type, ventilation, circumference, length, paper permeability and tobacco weight.[60] Combined with the reverse engineering evidence in this paper, there is significant evidence that the companies can measure a large number of ingredients and physical parameters accurately in their own and competitors' brands. Moreover, FSPTCA requires any ingredients or constituents that are considered 'harmful or potentially harmful constituents' by FDA to be quantified and disclosed and, therefore, could not be characterised as 'secret.'[58]

FDA's obligation to disclose tobacco product ingredients information that manufacturers submitted is firmly established. While the Federal Food, Drug and Cosmetic Act prohibits revealing trade secrets, it 'does not authorise the withholding of information from either House of Congress'[61] or from any member of the general public through a FOIA request.[62] Upon receiving a FOIA request, FDA is required to make the 'fullest possible disclosure' consistent with 'the need for the agency to promote frank internal policy deliberations and to pursue its regulatory activities without disruption', as well as trade secret protections.[63] FOIA contains exemptions against disclosure of trade secrets[14]; however, the Supreme Court has found these exemptions to be *permissive*, not mandatory.[64] Therefore, while FOIA permits FDA and other agencies to withhold information containing trade secrets, it does not require them to do so.

FOIA's '(b)(4) exemption' exempts disclosure of 'trade secrets and commercial or financial information obtained from a person and privileged or confidential.'[14] However, the burden is on the person who claims trade secret protection to demonstrate that the information should *not* be disclosed, not on FDA to prove that the information may be disclosed. If FDA receives a FOIA request for information that has been claimed to be a trade secret, but it is uncertain about whether that information is in fact protected, the regulations make clear that FDA must make its own investigation to determine if the material should be disclosed.[65] An alleged trade secret owner waives any objection to FDA's decision unless it files an action within 5 days of FDA's decision.[66]

An alleged trade secret owner may seek judicial review of FDA's decision to disclose in federal court under the Administrative Procedure Act.[67 68] In reviewing the agency's action, the court will examine the record developed by the agency and will only overturn the agency's actions if they were 'arbitrary, capricious, an abuse of discretion, or otherwise not in accordance with law.'[64 69] This standard would be very difficult to meet for a company seeking reversal of an FDA decision to disclose information, and courts typically defer to an agency's decision. The Supreme Court has held that the basic objective of FOIA is disclosure, and 'Congress did not design the FOIA exemptions to be mandatory bars to disclosure.'[70]

FDA (and similar regulatory authorities elsewhere) should disclose ingredients information submitted to it by tobacco companies for three reasons: (1) the information does not constitute trade secrets and, thus, is not entitled to trade secret protection[45–48]; (2) FDA is under no obligation to regard information it receives as trade secrets merely because a company that submits that information claims trade secret protection;[71–73] (3) FDA should exercise its discretion under the law to disclose records in the interest of protecting the public health.[74 75]

Limitations

The reverse engineering reports referenced in this paper are limited to documents available in LTDL that the tobacco companies produced as a result of litigation. At the time of our search, LTDL included 14 million documents. The 100 reports and 61 letters do not represent an exhaustive collection of all relevant documents in the LTDL. Our analysis is necessarily limited to these materials, but they are adequate to demonstrate the extent and nature of reverse engineering activities. While cigarettes have almost certainly changed since 2001 (the date of the last report we analysed), manufacturers' current capacity to reverse engineer is at least as powerful as it was then.

Conclusion

Despite the fact that the tobacco companies have told regulators that the ingredients in their products are valuable trade secrets[76] and these agencies have acceded to these requests,[13 77] the reality is that these ingredients and the construction of tobacco companies' products are not secret from their competitors. The actual ingredients and physical construction of current products remain secret only from the public. The major tobacco companies routinely determine levels of ingredients in their competitors' products through reverse engineering. Since this information is widely known outside of each company, it does not pass the two-prong test for trade secret protection: the information is neither commercially valuable nor secret.[45 47] Making ingredient information available to the public and scientific community would allow researchers to better understand the relationships between the physical parameters of cigarettes, their ingredients and the constituents in smoke. The manufacturers' and FDA's continued refusal to disclose by-brand ingredient information based on trade secret claims only serves to prevent consumers from receiving information that directly impacts their health.

What is already known on this subject

- The tobacco companies submit by-brand information on their products to regulatory agencies, but these agencies refuse to disclose this information based on the companies' claims that they are protected trade secrets.
- While it has been generally understood that tobacco companies have used reverse engineering to examine their competitors' products, the extent, frequency and detail level of these efforts has not been evaluated previously.

What this paper adds

- The major tobacco companies routinely, and with great frequency, examined the ingredients, physical parameters, and chemical composition of their competitors' products on a by-brand basis.
- This information was widely distributed to employees at all levels of the major tobacco companies, domestically and internationally.
- Because of the extensive analyses and wide distribution of cigarette ingredient information among the major tobacco companies, this information is neither secret nor commercially valuable, and is not entitled to trade secret protection.
- These findings have implications for public disclosure of cigarette ingredients information by regulatory agencies.

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REFERENCES

1 Djulancic N, Radojicic V, Srbinovska M. The influence of tobacco blend composition on Carbon Monoxide formation in mainstream cigarette smoke. *Arh Hig Rada Toksikol* 2013;64:107–13.
2 Fischer S, Spiegelhalder B, Preussmann R. Preformed tobacco-specific nitrosamines in tobacco—role of Nitrate and influence of tobacco type. *Carcinogenesis* 1989;10:1511–17.
3 Talhout R, Opperhuizen A, van Amsterdam JG. Sugars as tobacco ingredient: effects on mainstream smoke composition. *Food Chem Toxicol* 2006;44:1789–98.
4 IARC. *Acetaldehyde in re-evaluation of some organic chemicals, Hydrazine and Hydrogen Peroxide*. Lyon, France: Interrnational Agency for Research on Cancer, 1999. http://monographs.iarc.fr/ENG/Monographs/vol71/mono71.pdf
5 Stevenson T, Proctor RN. The secret and soul of Marlboro: Phillip Morris and the origins, spread, and Denial of Nicotine freebasing. *Am J Public Health* 2008;98:1184–94.
6 Wertz MS, Kyriss T, Paranjape S,, *et al* The toxic effects of cigarette additives. Philip Morris' project mix reconsidered: an analysis of documents released through litigation. *PLoS Med* 2011;8:e1001145.
7 Family Smoking Prevention and Tobacco Control Act, Pub. L. 111-31, 21 U.S.C § 387 (2009).
8 World Health Organization. WHO Framework Convention on Tobacco Control. 2005. http://whqlibdoc.who.int/publications/2003/9241591013.pdf (accessed 12 Dec 2013).
9 World Health Organization. Parties to the WHO Framework Convention on Tobacco Control. 2013. http://www.who.int/fctc/signatories_parties/en/index.html (accessed 12 Dec 2013).
10 European Parliament. *European Parliament. Directive 2014/…/Eu of the European Parliament and of the Council on the Approximation of the Laws, Regulations and Administrative Provisions of the Member States Concerning the Manufacture, Presentation and Sale of Tobacco and Related Products and Repealing Directive 2001/37/Ec; Brussells, 7 March 2014, Pe-Cons 143/13*. 2014. http://register.consilium.europa.eu/doc/srv?l=EN&t=PDF&gc=true&sc=false&f=PE%20143%202013%20INIT
11 Philip Morris, Inc., *Et Al*. V. Reilly, *Et Al*., 312 F.3d 24 (1st Cir. 2002).
12 Glantz SA. *Foia Requests to Fda Re Substantially Equivalent Stn Se0003730 and Stn Se0003731*. 2 August, 2013.
13 FDA FOIA officer. *Scanned Substantial Equivalence Applications, Correspondence, and Combined Reviews*. 13 August 2013.
14 5 U.S.C. Section 552(B)(4).
15 American Tobacco. *Blend Characterization of 85 Mm Marlboro by Dmp Task Force*. American Tobacco, 1971. http://legacy.library.ucsf.edu/tid/wbf11a00 (accessed 25 Sep 2013).
16 Cousins A. *Analysis of Winston Cigarettes Imported into Venezuela. Analysis of Winston Cigarettes Imported into Venezula*. Brown & Williamson, 1969. http://legacy.library.ucsf.edu/tid/mve51f00 (accessed 24 Sep 2013).
17 Johnson R. *Chemical analysis of blend components 840000 production full-flavor and lights nonmenthol brands*. Brown & Williamson, 1984. http://legacy.library.ucsf.edu/tid/ywv23f00 (accessed 24 Sep 2013).
18 Whitton T. *Mapping of 15 brands from the Swiss market using X-ray fluorescence and Fourier transform infra-red spectroscopy*. British American Tobacco, 1986. http://legacy.library.ucsf.edu/tid/gel18a99 (accessed 24 Sep 2013).
19 Resnik F. *1958 Accomplishments—1959 objectives and plans instrument section 580902*. Philip Morris, 1958. http://legacy.library.ucsf.edu/tid/mlq64e00 (accessed 25 Sep 2013).
20 Greene F, Ikeda R, Palmer A. Completion report gas phase profile. Philip Morris, 1969. http://legacy.library.ucsf.edu/tid/vbk36e00
21 Blackmore R, Creamer R, Ikeda R,, *et al Paper No. 8 Thermogravimetric studies of some tobacco types*. Philip Morris, 1962. http://legacy.library.ucsf.edu/tid/wtr81a00 (accessed 24 Sep 2013).
22 Glock E. *Distribution of blend components in competitive cigarette brands. Ii. selected Lorillard Brands*. American Tobacco, 1978. http://legacy.library.ucsf.edu/tid/fsy64f00 (accessed 12 Sep 2013).
23 Lauterbach J, Johnson R. *R&D-B053-89 C. 15 the project adverb study of Marlboro Ks*. Brown & Williamson, 1989. http://legacy.library.ucsf.edu/tid/lvs20f00 (accessed 23 Aug 2013).
24 RJ Reynolds. *Factoids*. RJ Reynolds, 1994. http://legacy.library.ucsf.edu/tid/gyo75a00 (accessed 10 Sep 2013).
25 Chambers H. Product Testing Laboratory Final Laboratory Averages Report Ci Domestic—to Test Winston 100 Percent Natural Blend as a New Brand. 1997. http://legacy.library.ucsf.edu/tid/swn49c00
26 Craven B, Johnson J. Analysis of Winston 100 percent tobacco 'No Additive' cigarettes Q-449 analytical support. 1996. http://legacy.library.ucsf.edu/tid/ovv57h00
27 Johnson RR. Pgs-B057-85 Dunhill Lights Box Ks and 100 S Dr. R.R. Johnson 851001 Project 151. 01 October 1985. Research. http://legacy.library.ucsf.edu/tid/ypn86b00 (accessed 30 Sep 2013).
28 Kulshreshtha N, Moldoveanu S, Roles J. Analytical Results on Winston-on Additives/324. 1996. http://legacy.library.ucsf.edu/tid/ftj19j00
29 Mitchell K. *New brand introductions*. Philip Morris, 1991. http://legacy.library.ucsf.edu/tid/laq83e00
30 Dong Z, Kulshreshtha N, Moldoveanu S, *et al*. *The Eclipse smoking devic Ii. Analytical findings on smoke and tobbaco type materials /312*. Brown & Williamson, 1995. http://legacy.library.ucsf.edu/tid/cst03f00 (accessed 10 Sep 2013).
31 Holleman R. *Ci Highlights: Winston S2, Camel 'Exotic Blend' and Gsmoke Tsna Update*. Philip Morris, 2001. http://legacy.library.ucsf.edu/tid/rtn10i00 (accessed 2 Oct 2013).
32 RJ Reynolds. Second-Hand Smoke—a Thing of the Past? Almost (Press Release). 1996. http://legacy.library.ucsf.edu/tid/rtr17a00
33 Slade J, Connolly GN, Lymperis D. Eclipse: does it live up to its health claims? *Tob Control* 2002;11(Suppl 2):ii64–70.
34 Stepnowski R. Progress Report Number 7 on Eclipse Cigarettes—Smoking Lab Analysis and Determination of Phenols in Mainstream Smoke Q 449. 1996. http://legacy.library.ucsf.edu/tid/aqc67h00
35 Vaughan C, Stanfill SB, Polzin GM, *et al*. Automated determination of seven Phenolic compounds in mainstream tobacco smoke. *Nicotine Tob Res* 2008;10:1261–8.
36 Larson T. Progress Report on the New Eclipse (Hollow Filter) Cigarettes B 622. Lorillard, 1997. http://legacy.library.ucsf.edu/tid/xrc67h00
37 Pasterczyk R. *Percent Winston was additive-free prior to natural*. RJ Reynolds, 1995. http://legacy.library.ucsf.edu/tid/zto95i00 (accessed 25 Oct 2013).
38 American Tobacco. Competitive brand analysis report. American Tobacco, 1970. http://legacy.library.ucsf.edu/tid/zdg12i00 (accessed 20 Sep 2013).
39 Newsome J. *Evaluation of competitive cigarettes*. Liggett & Myers, 1975. http://legacy.library.ucsf.edu/tid/ayz57a00 (accessed 12 Aug 2013).
40 Newsome J. *Development of a cigarettes with an increased smoke Ph*. Liggett & Myers, 1976. http://legacy.library.ucsf.edu/tid/wad47a00 (accessed 01 Oct 2013).
41 Gordon D. *B&W R&D PM S global strategy: Marlboro product technology. A summary developed with input from Batco, Batcf, Souza Cruz, & B&W*. Brown & Williamson, 1992. http://legacy.library.ucsf.edu/tid/hus20f00 (accessed 13 Aug 2013).
42 Johnson R, Lin O. *R&D-B026-86. Key brands analysis for reverse engineering*. Brown & Williamson, 1986. http://legacy.library.ucsf.edu/tid/enr20f00 (accessed 23 Sep 2013).
43 RJ Reynolds. *1991 product quality evaluation of RJR versus competitive brands and 1990 RJR Versus 1991 RJR Physicals, FTC smoke and chemicals*. RJ Reynolds, 1991. http://legacy.library.ucsf.edu/tid/yse38c00 (accessed 27 Nov 2013).

44 Uniform Law Commission. Legislative Fact Sheet—Trade Secrets Act. 2013. http://www.uniformlaws.org/LegislativeFactSheet.aspx?title=Trade%20Secrets%20Act (accessed 12 Dec 2013).
45 National Conference of Commissioners on Uniform State Laws. Uniform Trade Secrets Act, Section 1(4) (as Amended 1985). http://www.uniformlaws.org/Act.aspx?title=Trade%20Secrets%20Act (accessed 27 May 2014).
46 California Civil Code Section 3426.1(D).
47 American Law Institute. St. Paul, MN Restatement of the Law, First: Torts (Sect. 757, Comment B) American Law Institute Publishers. http://www.lrdc.pitt.edu/ashley/RESTATEM.HTM (accessed 12 Dec 2013).
48 American Law Institute. Restatement (Third) of Unfair Competition, Section 39 (1995). http://www.wipo.int/wipolex/en/text.jsp?file_id=194019 (accessed 12 Dec 2013).
49 Kewanee Oil Co. V. Bicron Corp. 416 U.S. 470, 476 (1974).
50 Bonito Boats, Inc. V. Thunder Craft Boats, Inc. . 489 U.S. 141 (1989).
51 Family Smoking Prevention and Tobacco Control Act, Pub. L. 111-31, Sec. 904(a)(1) (2009).
52 Family Smoking Prevention and Tobacco Control Act, Pub. L. 111-31, Sec. 904(a)(2) (2009).
53 Family Smoking Prevention and Tobacco Control Act, Pub. L. 111-31, Sec. 904(a)(3) (2009).
54 Family Smoking Prevention and Tobacco Control Act, Pub. L. 111-31, Sec. 904(a)(4), 904(B)(1) (2009).
55 Family Smoking Prevention and Tobacco Control Act, Pub. L. 111-31, Sec. 904, 905, 910 (2009).
56 Family Smoking Prevention and Tobacco Control Act, Pub. L. 111-31, Sec. 904(C)(2) (2009).
57 World Health Organization. WHO Framework Convention on Tobacco Control, Guidelines for Implementation, Article 5.3, Article 8, Articles 9 and 10, Article 11, Article 12, Article 13, Article 14 (2013 Edition). 2013. http://apps.who.int/iris/bitstream/10665/80510/1/9789241505185_eng.pdf (accessed 12 Dec 2013).
58 Family Smoking Prevention and Tobacco Control Act, Pub. L. 111-31, Sec. 904(D)(1) (2009).
59 FDA. Fda Transparency Website. http://www.fda.gov/AboutFDA/Transparency/ (accessed 25 Mar 2014).
60 Borgerding MF, Bodnar JA, Wingate DE. The 1999 Massachusetts Benchmark Study; Final Report. Brown & Williamson, 2000. http://legacy.library.ucsf.edu/tid/yek21c00 (accessed 25 Feb 2013).
61 21 U.S.C. Section 331(J) (2006).
62 45 C.F.R. Section 5.31(2009).
63 21 C.F.R. Section 20.20 (2010).
64 Chrysler Corp. V. Brown, 441 U.S. 281 (1979).
65 21 C.F.R. Section 20.47 (2010).
66 21 C.F.R. Section 20.55 (2010).
67 21 C.F.R. Section 20.48 (2010).
68 5 U.S.C. Sections 701-706 (2006).
69 5 U.S.C. Sections 706 (2006).
70 Chrysler Corp. V. Brown, 441 U.S. 281, 293 (1979).
71 21 C.F.R. Section 20.61(D).
72 21 C.F.R. Section 20.27.
73 21 C.F.R. Section 20.61(E).
74 21 C.F.R. Section 20.80(a).
75 21 C.F.R. 20.81(a).
76 Barald P. *Massachusetts Benchmark Study*. RJ Reynolds, 1999. http://legacy.library.ucsf.edu/tid/fqt82a00 (accessed 15 Apr 2013).
77 Archer W. *The confidentiality of ingredients in tobacco products submitted to the texas department of health*. Philip Morris, 1999. http://legacy.library.ucsf.edu/tid/ciw95g00 (accessed 13 Aug 2013).