

Principal Components Analysis

Magnetic force measurements at 11 positions on each of 44 rods

Rod #	Magnetic Force Measurements											Configuration		Metal
	L1	L2	L3	L4	L5	L6	L7	L8	L9	L10	L11	Current		
1	136	142	139	131	122	118	134	138	148	149	171	0	0	1
2	639	723	782	756	804	804	909	962	1042	1058	1022	250	0	1
3	673	709	709	719	682	681	759	912	1122	1121	900	500	0	1
4	471	501	521	519	528	521	540	523	548	525	513	0	1	2
5	578	617	650	625	632	634	677	695	733	735	747	250	0	1
6	120	124	110	110	104	104	126	140	158	164	182	500	1	2
7	542	578	583	598	587	618	654	696	737	726	752	0	0	3
8	597	632	631	655	659	699	792	890	972	960	953	250	0	3
9	615	641	634	649	648	699	809	892	975	974	968	500	0	3
10	487	486	485	489	488	487	491	490	500	483	471	0	1	4
11	113	127	124	116	107	110	131	143	161	163	171	250	1	4
12	563	579	586	613	635	689	806	907	1013	1025	973	500	1	4
13	436	456	455	465	469	468	472	471	486	464	457	0	1	1
14	492	527	546	565	583	602	658	692	748	756	744	250	1	1
15	109	119	113	101	94	100	122	136	155	160	178	500	1	1
16	589	589	568	584	589	626	652	663	699	710	726	0	0	2
17	623	624	608	630	657	710	795	865	960	971	961	250	0	2
18	492	497	482	487	487	497	492	492	492	482	471	500	0	2
19	452	462	466	481	485	484	493	487	496	479	473	0	1	3
20	665	670	670	681	681	702	791	864	954	980	969	250	1	3
21	147	151	143	130	120	123	145	160	179	187	209	500	1	3
22	466	471	466	477	487	482	477	487	487	482	471	0	0	4
23	568	600	601	612	617	618	661	687	735	752	773	250	0	4
24	581	613	607	628	639	628	692	723	792	803	803	500	1	1
25	634	701	706	721	742	736	846	924	1038	1048	1001	500	1	1
26	684	694	694	710	821	1236	963	857	936	952	921	0	0	2
27	112	120	115	106	96	99	121	138	156	162	179	250	0	2
28	608	623	634	655	665	712	802	933	1048	1027	995	500	0	2
29	477	466	471	482	487	482	482	487	492	477	461	0	1	3
30	545	561	572	599	604	615	658	721	774	764	770	250	1	3
31	584	588	582	612	611	621	667	697	733	732	752	500	1	3
32	100	118	115	109	101	106	130	145	162	164	172	0	0	4
33	573	584	605	626	652	642	684	694	721	705	721	500	0	4
34	589	603	627	656	681	689	782	861	967	970	936	0	0	1
35	521	551	571	596	616	647	772	861	981	964	963	250	0	1
36	447	446	445	465	469	457	472	476	481	464	463	500	0	1
37	494	478	472	493	492	481	491	491	490	463	473	0	1	2
38	99	112	109	102	94	99	122	137	153	157	168	250	1	2
39	587	617	616	631	640	676	769	878	987	986	980	500	0	3
40	471	471	465	480	480	484	489	489	488	472	471	0	0	3
41	542	562	561	581	585	610	651	692	728	722	747	250	0	3
42	545	545	545	566	587	592	618	649	697	686	702	0	1	4
43	692	687	703	720	747	768	843	891	992	1014	982	250	1	4
44	655	696	679	694	734	864	837	847	924	923	964	500	1	4

AVE: 479.8 496.8 499.2 509.7 518.3 541.4 579.1 613.2 664.5 662.8 656.3
 SD: 185.2 191.5 196.5 204.0 215.4 245.0 249.8 271.6 307.4 309.9 294.1

Magnetic Force on Rods in Printers—A Controlled Experiment

Engineers manipulated three factors to enhance the magnetic force surrounding a metal rod in an electronic printer: the electric current passing through the rod (0, 250, or 500 milliamperes); the configuration of components (0 or 1); and the type of metal from which the rod was made (1, 2, 3, or 4). Arranged factorially the current, configuration, and metal options yield $3 \times 2 \times 4 = 24$ possible treatment combinations.

With a given treatment combination, a printer operated for 2 minutes; then the engineers measured the magnetic force at 11 equally spaced points along the rod. Two replicates were attempted for each treatment combination. Four trials failed, so the full data set in Display 17.1 contains only 44 trials. These unpublished data were provided by Dr. V. J. Willman.

The factors effects are not significant.

Summary for principal components analysis of magnetic force responses

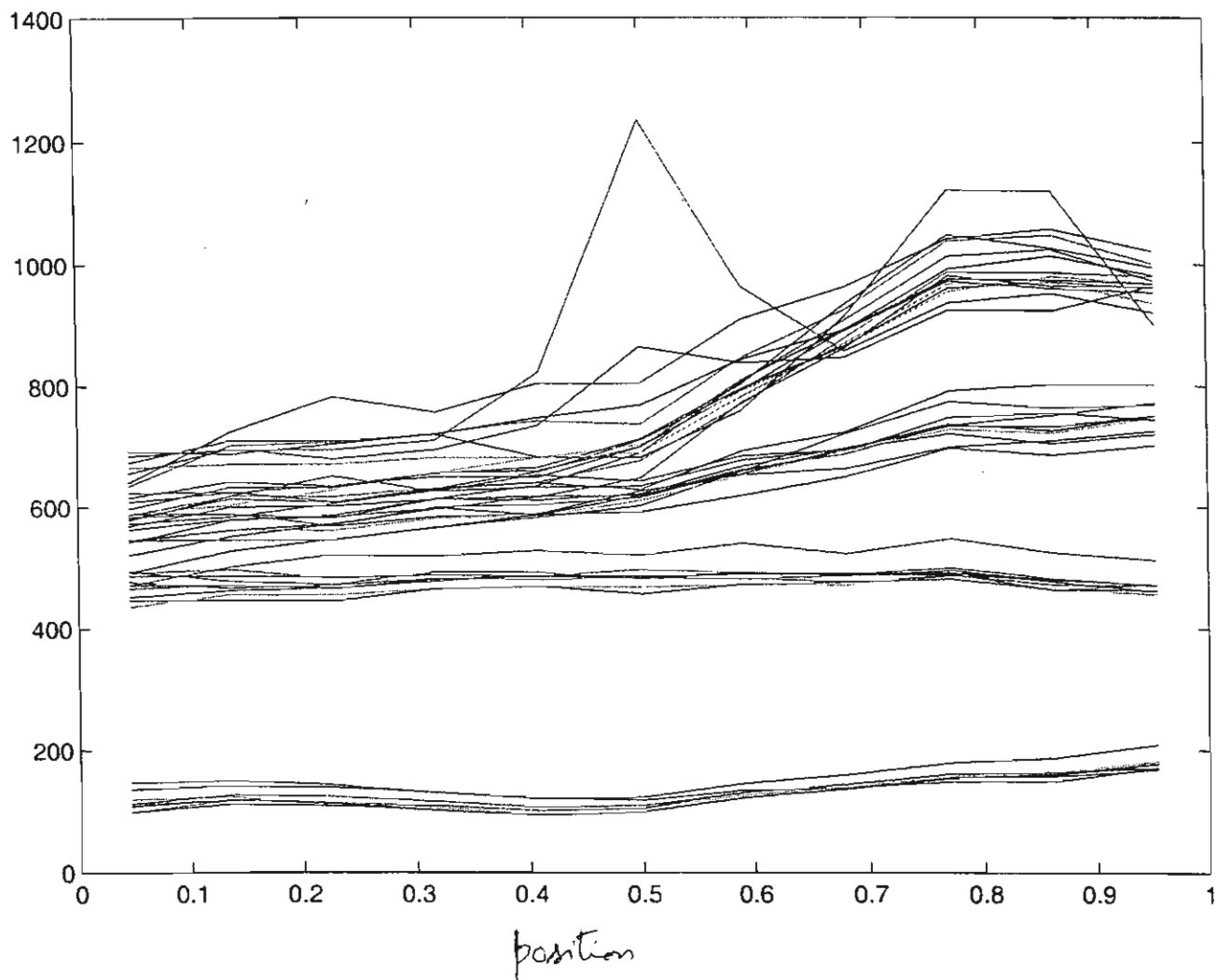
a. Variability of Principal Components

Component Number	Variance	Percent of Variance	Cumulative Percentage
1	646,948	96.46	96.46
2	17,247	2.57	99.03
3	4,684	0.70	99.73
4	901	0.13	99.86
5	448	0.07	99.93
6	240	0.04	99.97
7	99	0.01	99.98
8	63	0.01	99.99
9	28	0.00	100.00
10	17	0.00	100.00
11	13	0.00	100.00

b. Coefficient Table for First Three Principal Components

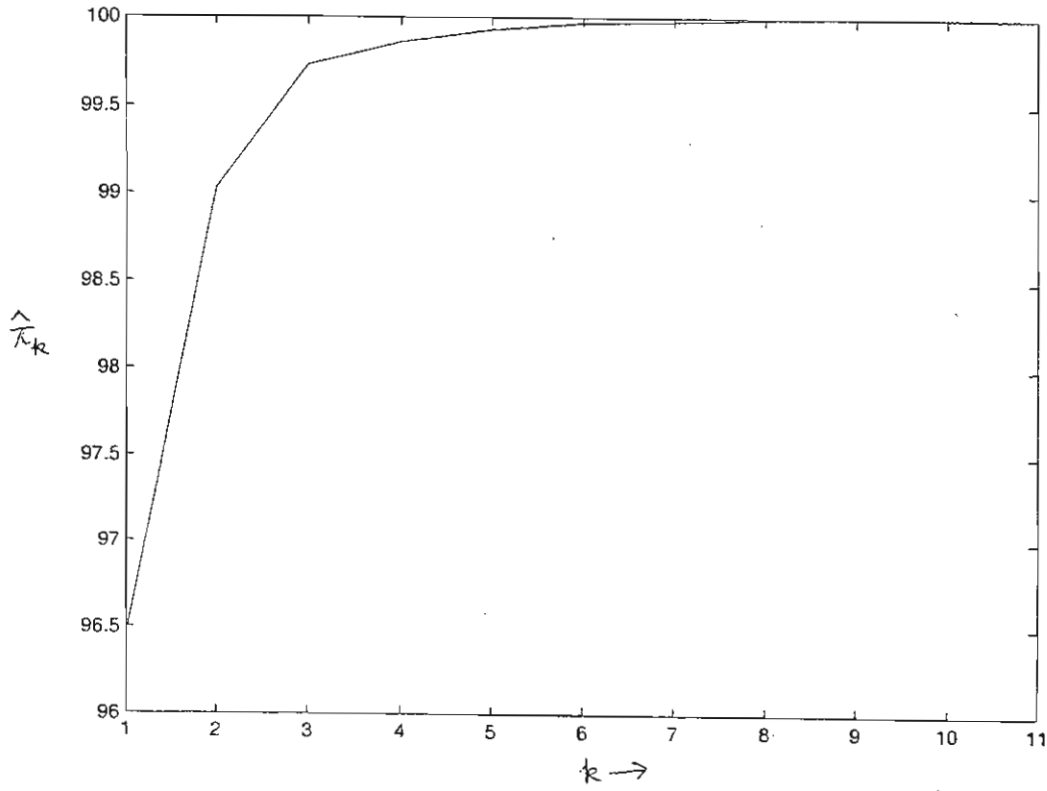
Variable	PC #1	PC #2	PC #3
Location 1	.2228	-.3041	-.2588
Location 2	.2327	-.2653	-.2699
Location 3	.2390	-.2596	-.2909
Location 4	.2486	-.2639	-.2926
Location 5	.2627	-.3068	-.0670
Location 6	.2901	-.3875	.7913
Location 7	.3095	-.0832	.2005
Location 8	.3360	.1785	-.0787
Location 9	.3769	.3697	-.0546
Location 10	.3792	.4044	-.0002
Location 11	.3601	.3419	.0995

Plot of Magnetic Force data

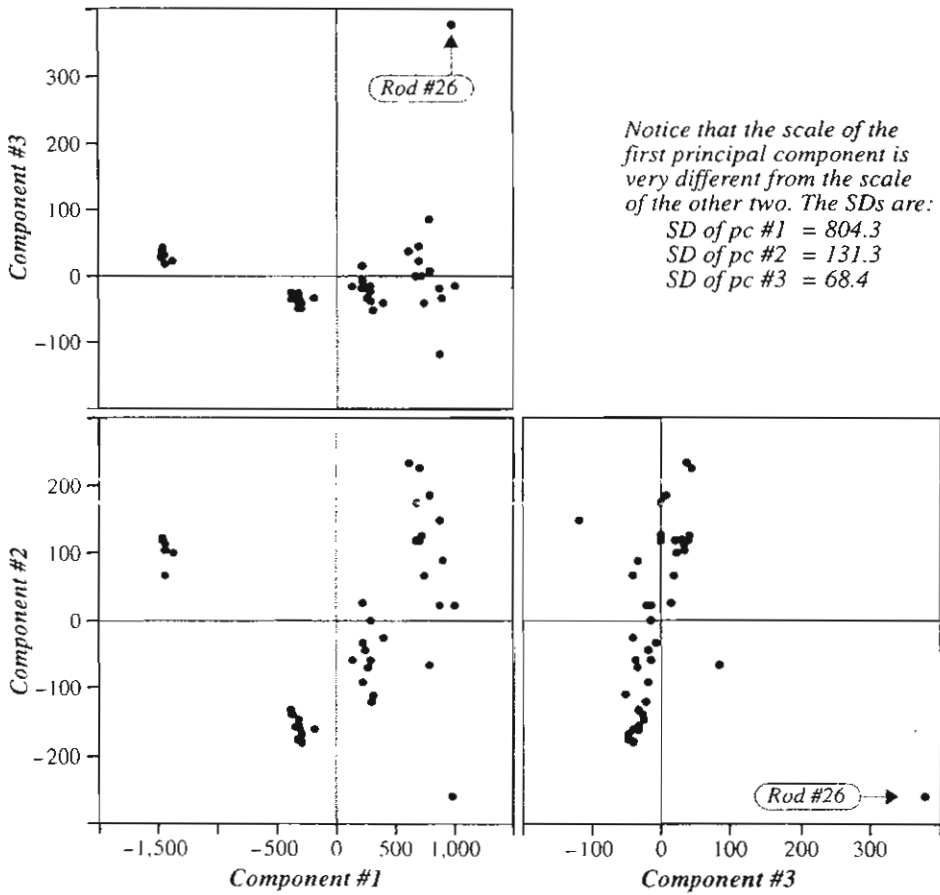


Magnetic force data

Cumulative proportion of sample eigenvalues.

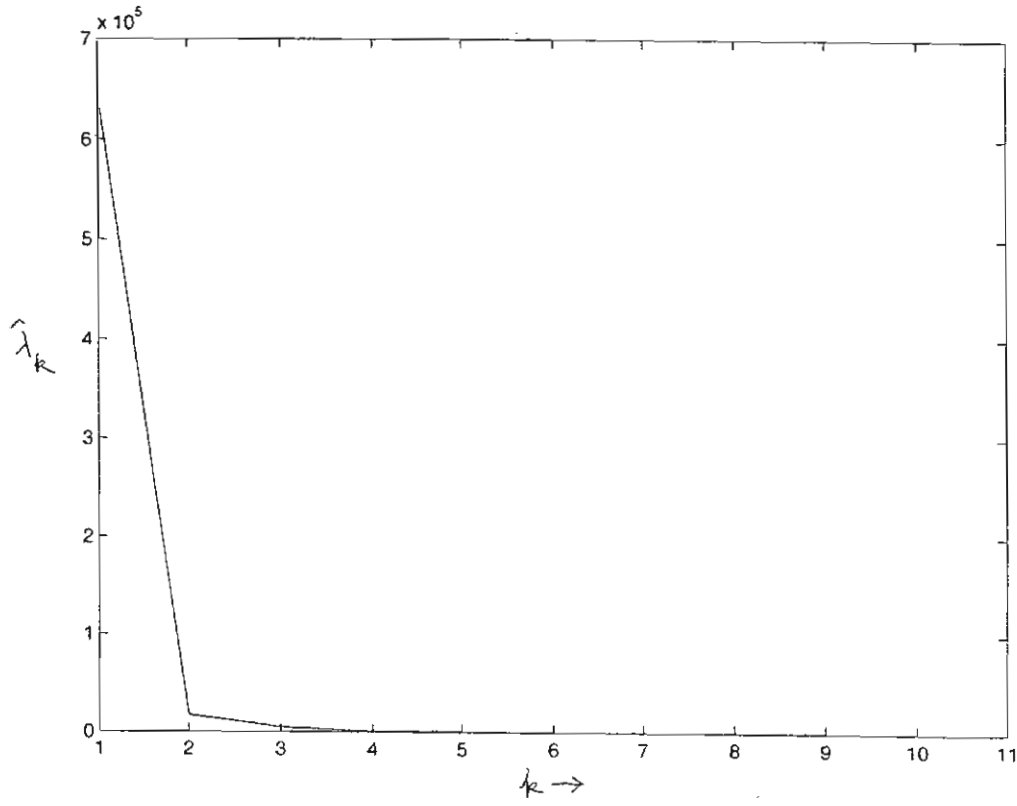


Matrix of scatterplots for the first three principal components of the magnetic force measurements



Magnetic force data

Scree plot



Modified Scree plot

