Introduction to the Cyranose 320 for QA/QC Sensing Applications

A few applications highlight the advantages of portable and affordable sensing for:

- Incoming inspection and verification of bulk chemicals
- Confirmation of raw materials, ingredients
- Batch confirmation
- Process line change-over
- Product authentication
- Product quality, contamination and aging

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Cyranose™ 320 Handheld Instrument

Fully-Integrated Sensing Instrument

- sampling system, sensor array, software

Consistent, Robust, Reliable Manufacturing

- in production for over 10 yrs
- systems in use worldwide
- many systems in regular use for 5 to 10 yrs
- over 90 3rd party industrial research publications
- over 70 3rd party medical research publications for a variety of conditions

Stable, Robust, Reliable Sensors

- nanocomposite sensors exhibit high sensitivity (ppm to ppb detection limits) for volatile and semi-volatile organic compounds (VOCs)
- sensor technology originally developed at the California Institute of Technology (Caltech)
- over 60 patents for sensors, detector, software, and applications

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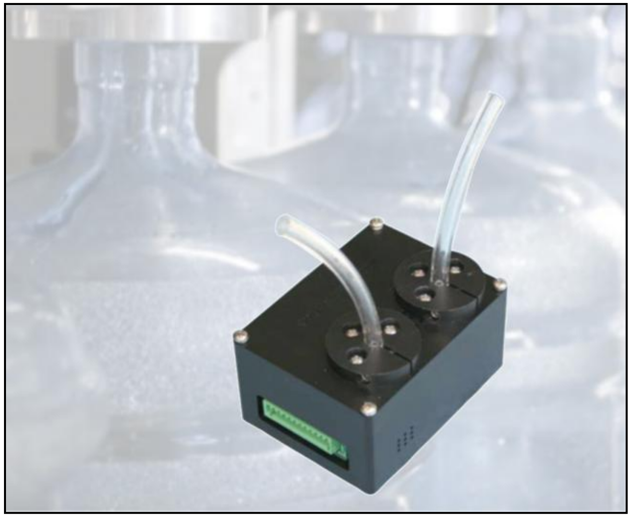
eNose™ Sensor Products



eNose™ Sensors are Integrated in Industrial Process Equipment

- automated product handling equipment
- automated product testing equipment

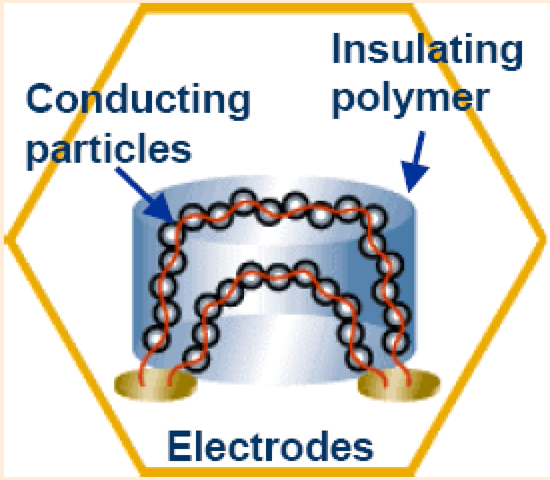
Sensors used in Cyranose 320 handheld

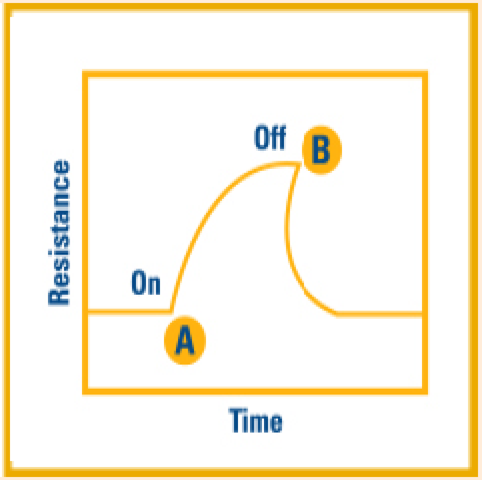
eNose™ Aqua

Sensor Product for the global Bottled Water Industry first introduced in 2007

- continuous 24 / 7 / 365 operation
- sensors in operation for over 4 years worldwide
- 2 second measurement cycle
- over 100,000 cycles per week in high-throughput bottling plants

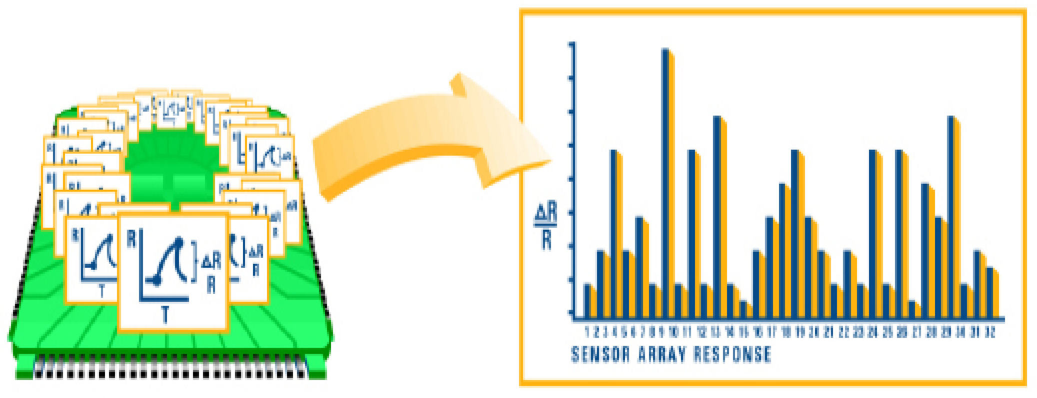
Nanocomposite Sensor Technology





Sensing Mechanism

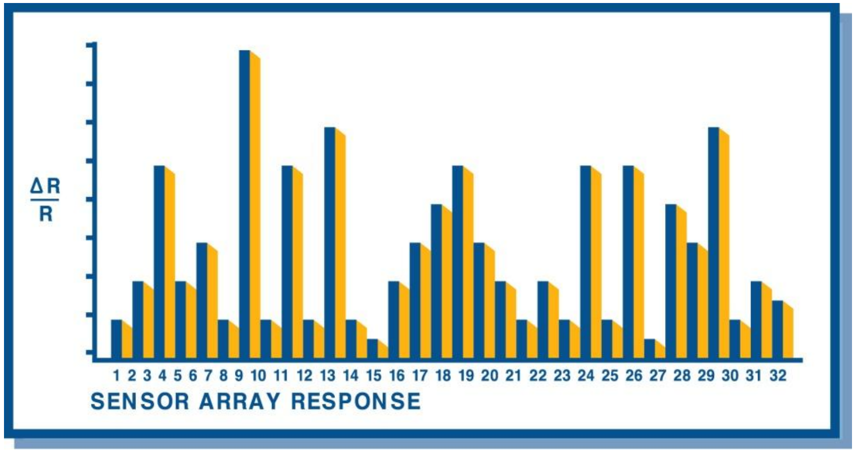
- Vapor passes over the polymer matrix and produces a change in dc resistance for each sensor
- 32 chemical sensors in array

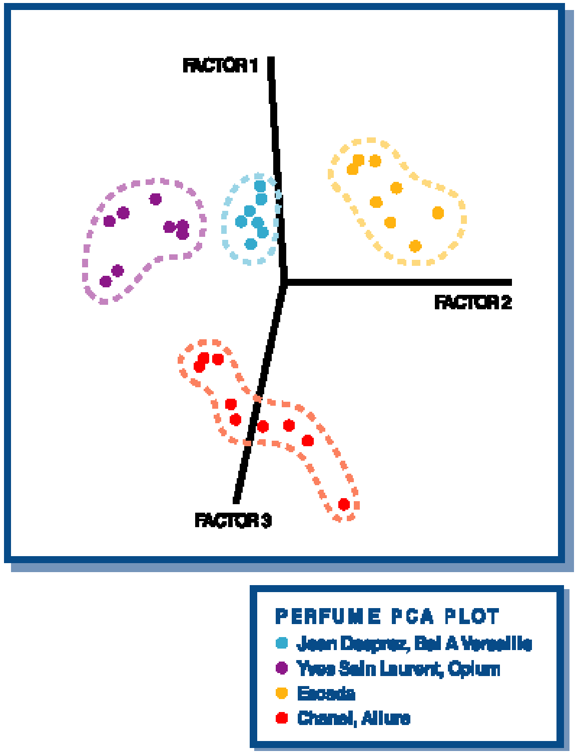


Identification

- Using pattern matching algorithms, the data is converted into a unique response pattern

Visualizing 32-Dimensional Space for 4 Vapors





Pattern Recognition

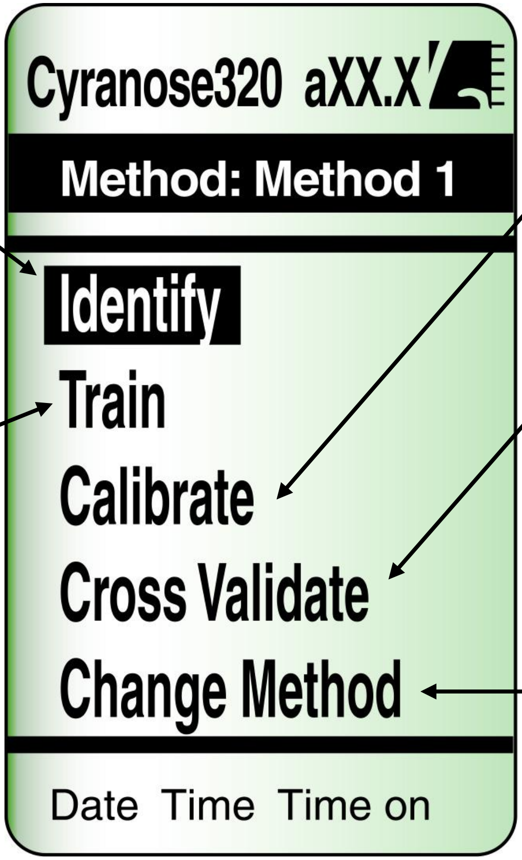
Comparison of complex data yields simple answers

Cyranose™ 320 System

- Hard carry case
- NiMH battery pack
- Communication cables
- External power adaptor
- Accessories
- CD ROM
  - Quick tour of product
  - PCnose software
  - Operations Manual
  - Application Guide

Cyranose™ 320 Handheld

Cyranose 320 - Handheld User Interface



Cyranose320 aXX.X

Method: Method 1

Identify

Train

Calibrate

Cross Validate

Change Method

Date Time Time on

Identify mode is used to predict a sample

Train mode is used to teach the Cyranose® 320 your class patterns

Calibrate the training set

Build the statistical model of your training set data and check your training set data

Select the active method

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Cyranose 320 – PC Software

Welcome to the new Cyranose 320 electronic nose, the efficient and affordable way to accurately perform on-site analysis.

Cyranose 320 - PC Software

Method development

- Easy to use
- Data visualization options
- Control of instrument parameters

Two-way communication

- Transfer method files between PC and handheld
- Unlimited methods for different sensing applications
- Saving raw data

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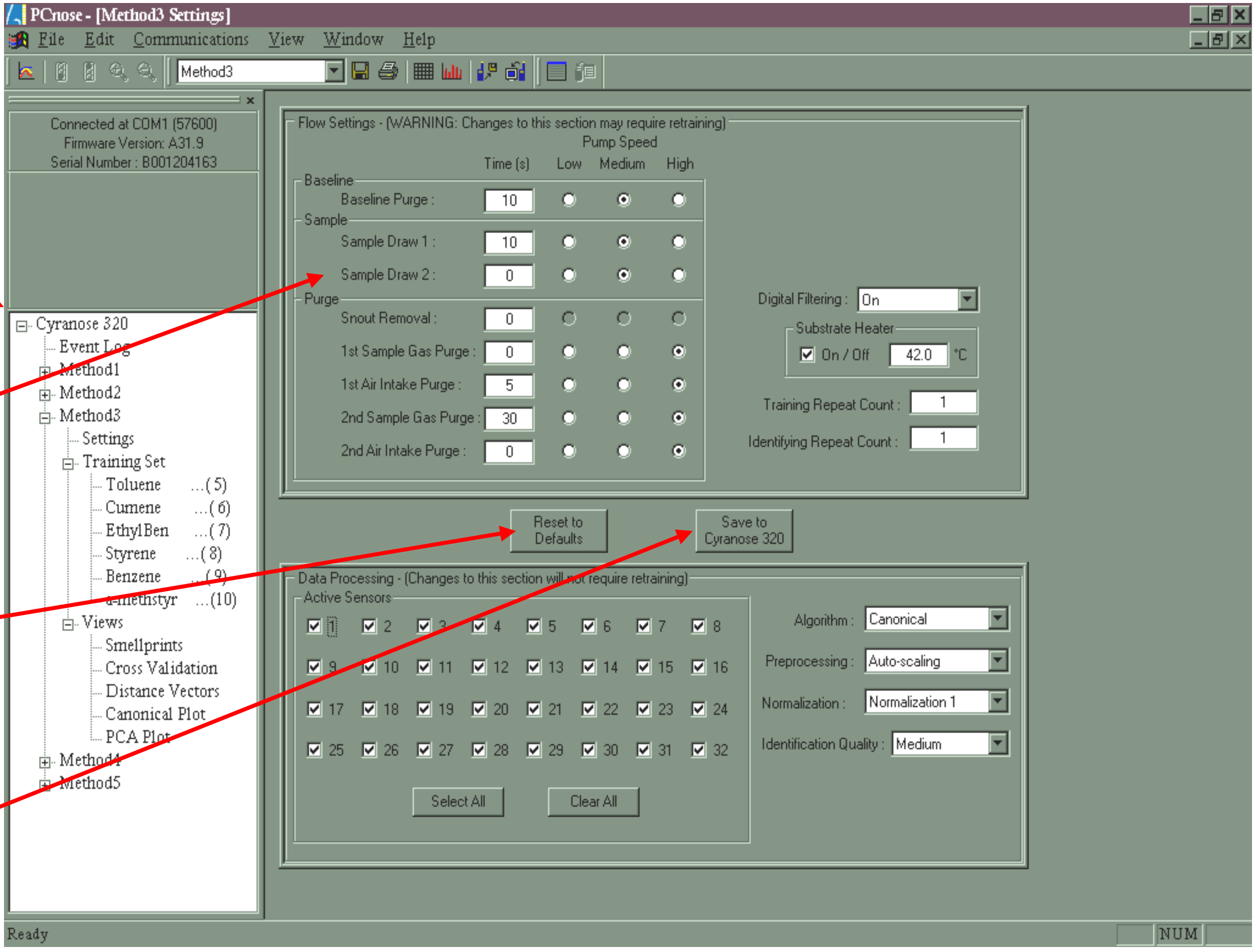
Cyranose 320 - PC User Interface

Easy navigation around Cyranose 320

Simple set up options

Reset settings to Default

Transfer Method to Cyranose 320



Connected at COM1 (57600)
Firmware Version: A31.9
Serial Number : B001204163

Flow Settings - (WARNING: Changes to this section may require retraining)

	Time (s)	Pump Speed Low	Medium	High
Baseline				
Baseline Purge :	10	○	●	○
Sample				
Sample Draw 1 :	10	○	●	○
Sample Draw 2 :	0	○	●	○
Purge				
Snout Removal :	0	○	○	○
1st Sample Gas Purge :	0	○	○	●
1st Air Intake Purge :	5	○	○	●
2nd Sample Gas Purge :	30	○	○	●
2nd Air Intake Purge :	0	○	○	●

Digital Filtering : On

Substrate Heater
☑ On / Off 42.0 °C

Training Repeat Count : 1

Identifying Repeat Count : 1

Data Processing - (Changes to this section will not require retraining)

Active Sensors

☑ 1	☑ 2	☑ 3	☑ 4	☑ 5	☑ 6	☑ 7	☑ 8
☑ 9	☑ 10	☑ 11	☑ 12	☑ 13	☑ 14	☑ 15	☑ 16
☑ 17	☑ 18	☑ 19	☑ 20	☑ 21	☑ 22	☑ 23	☑ 24
☑ 25	☑ 26	☑ 27	☑ 28	☑ 29	☑ 30	☑ 31	☑ 32

Algorithm : Canonical

Preprocessing : Auto-scaling

Normalization : Normalization 1

Identification Quality : Medium

Cyranose 320 – Complete Control for Method Development

Select:

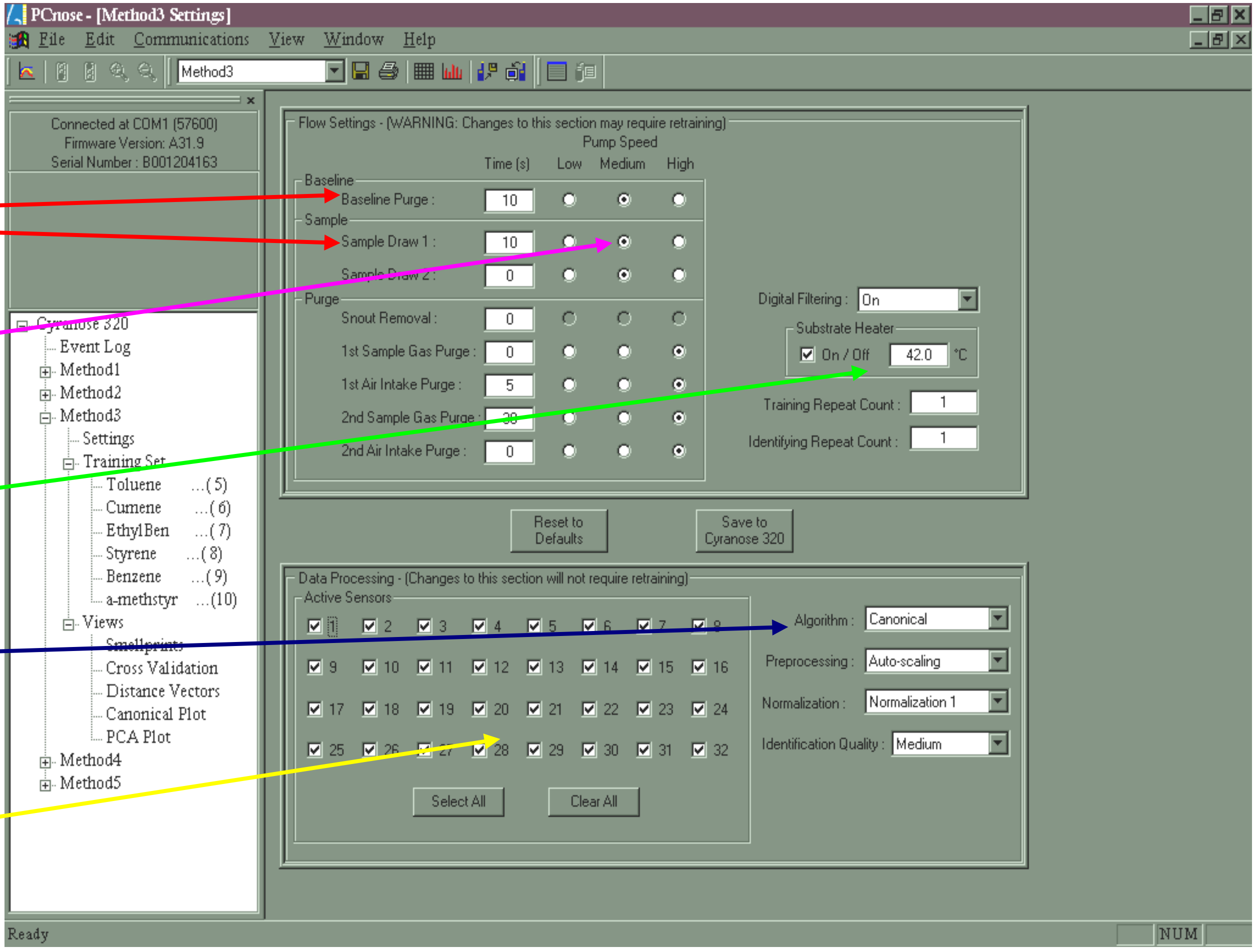
Timings

Pump Speeds

Sensor Temp.

Algorithm

Sensors



Connected at COM1 (57600)
Firmware Version: A31.9
Serial Number : B001204163

- Cyranose 320
  - Event Log
  - Method1
  - Method2
  - Method3
    - Settings
    - Training Set
      - Toluene ...(5)
      - Cumene ...(6)
      - EthylBen ...(7)
      - Styrene ...(8)
      - Benzene ...(9)
      - a-methstyr ...(10)
    - Views
      - Smellprints
      - Cross Validation
      - Distance Vectors
      - Canonical Plot
      - PCA Plot
  - Method4
  - Method5

Flow Settings - (WARNING: Changes to this section may require retraining)

	Time (s)	Pump Speed Low	Medium	High
Baseline				
Baseline Purge :	10	○	●	○
Sample				
Sample Draw 1 :	10	○	●	○
Sample Draw 2 :	0	○	●	○
Purge				
Snout Removal :	0	○	○	○
1st Sample Gas Purge :	0	○	○	●
1st Air Intake Purge :	5	○	○	●
2nd Sample Gas Purge :	30	○	○	●
2nd Air Intake Purge :	0	○	○	●

Digital Filtering : On

Substrate Heater: ☑ On / Off 42.0 °C

Training Repeat Count : 1

Identifying Repeat Count : 1

Reset to Defaults | Save to Cyranose 320

Data Processing - (Changes to this section will not require retraining)

Active Sensors

☑ 1	☑ 2	☑ 3	☑ 4	☑ 5	☑ 6	☑ 7	☑ 8
☑ 9	☑ 10	☑ 11	☑ 12	☑ 13	☑ 14	☑ 15	☑ 16
☑ 17	☑ 18	☑ 19	☑ 20	☑ 21	☑ 22	☑ 23	☑ 24
☑ 25	☑ 26	☑ 27	☑ 28	☑ 29	☑ 30	☑ 31	☑ 32

Select All | Clear All

Algorithm : Canonical

Preprocessing : Auto-scaling

Normalization : Normalization 1

Identification Quality : Medium

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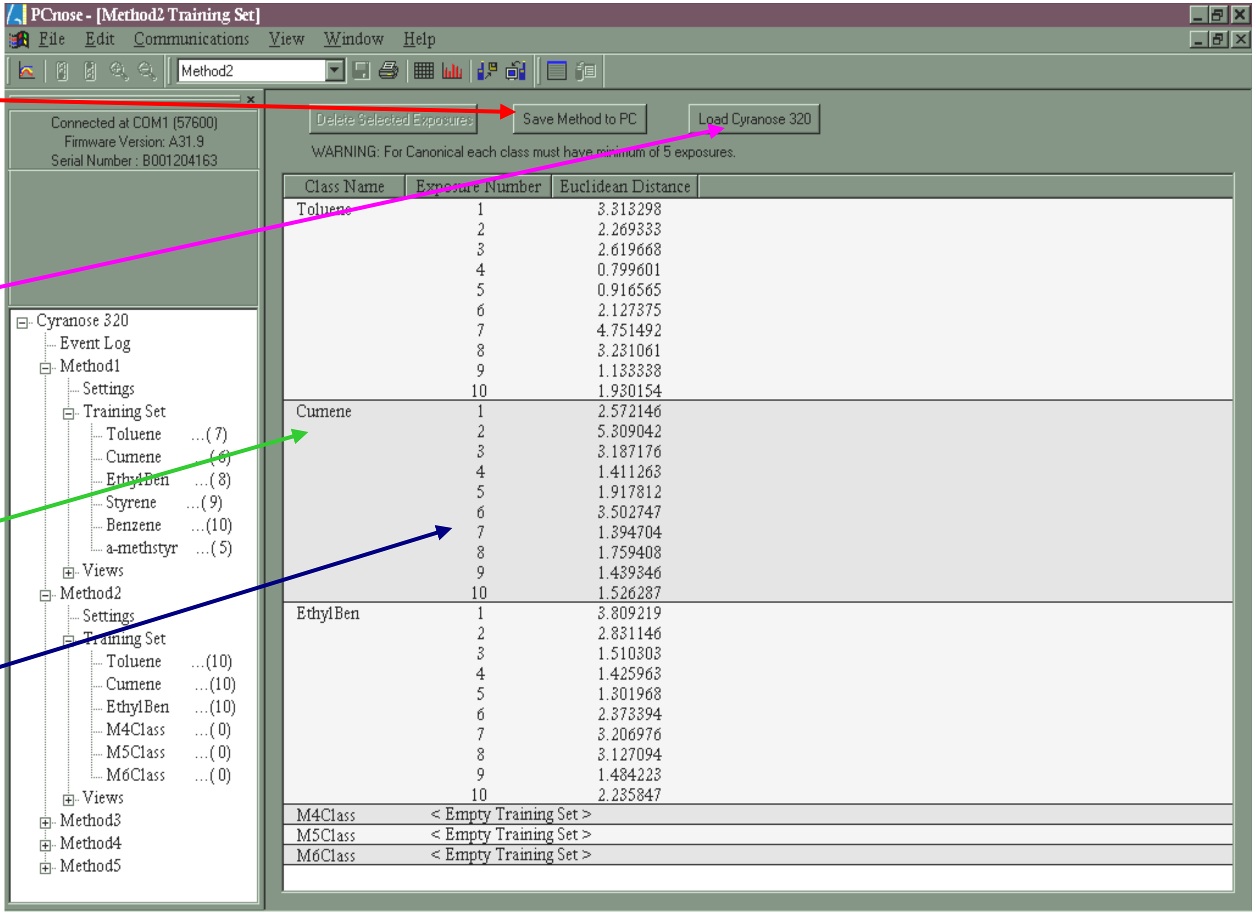
Cyranose 320 – Device Training

Saving training set to PC

Loading a training set to the Cyranose 320

Class Name

Exposure Number

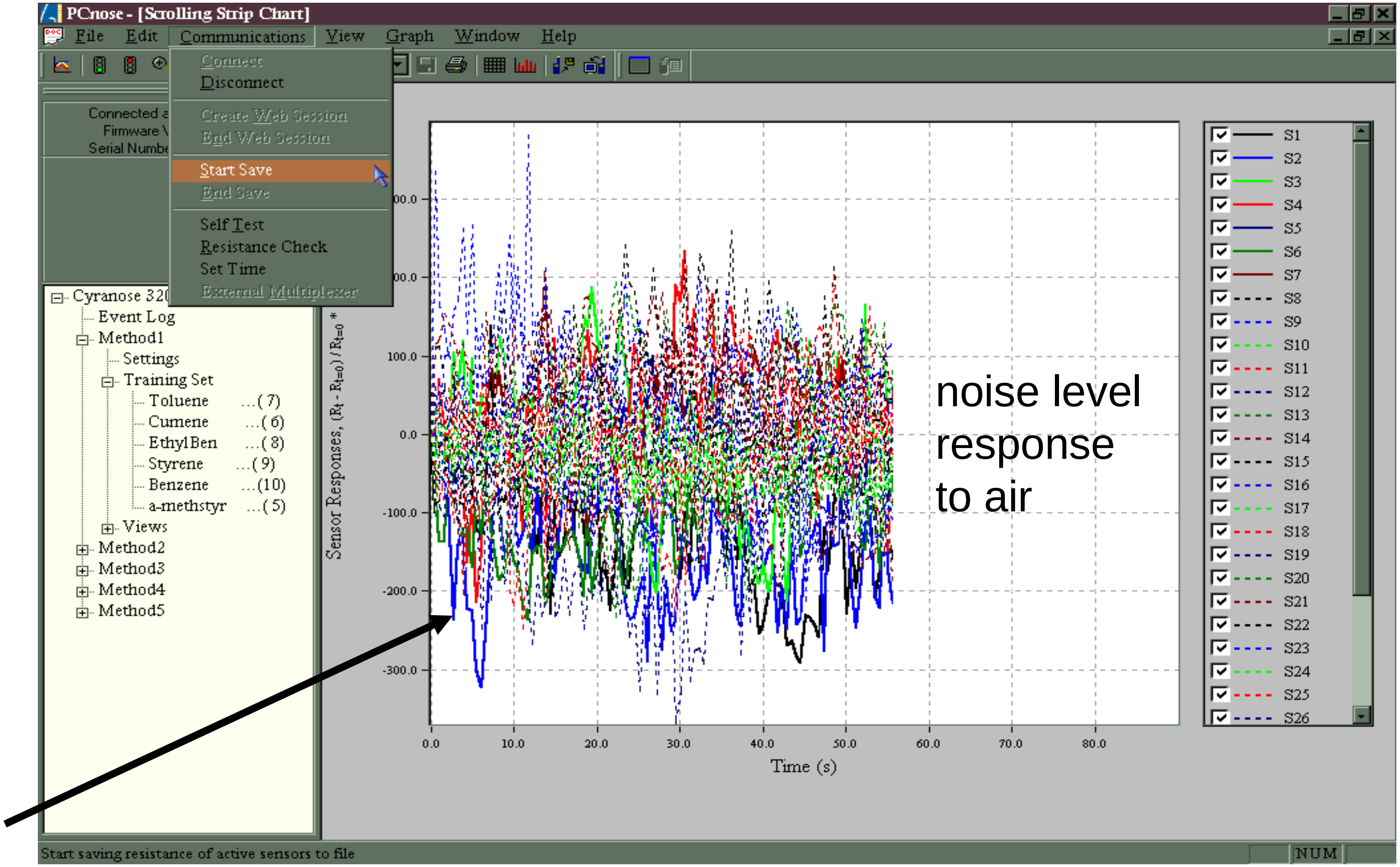


Connected at COM1 (57600)
Firmware Version: A31.9
Serial Number : B001204163

WARNING: For Canonical each class must have minimum of 5 exposures.

Class Name	Exposure Number	Euclidean Distance
Toluene	1	3.313298
	2	2.269333
	3	2.619668
	4	0.799601
	5	0.916565
	6	2.127375
	7	4.751492
	8	3.231061
	9	1.133338
	10	1.930154
Cumene	1	2.572146
	2	5.309042
	3	3.187176
	4	1.411263
	5	1.917812
	6	3.502747
	7	1.394704
	8	1.759408
	9	1.439346
	10	1.526287
EthylBen	1	3.809219
	2	2.831146
	3	1.510303
	4	1.425963
	5	1.301968
	6	2.373394
	7	3.206976
	8	3.127094
	9	1.484223
	10	2.235847
M4Class	< Empty Training Set >	
M5Class	< Empty Training Set >	
M6Class	< Empty Training Set >	

Cyranose 320 – Log Raw Data



Start saving resistance of active sensors to file

noise level response to air

room air

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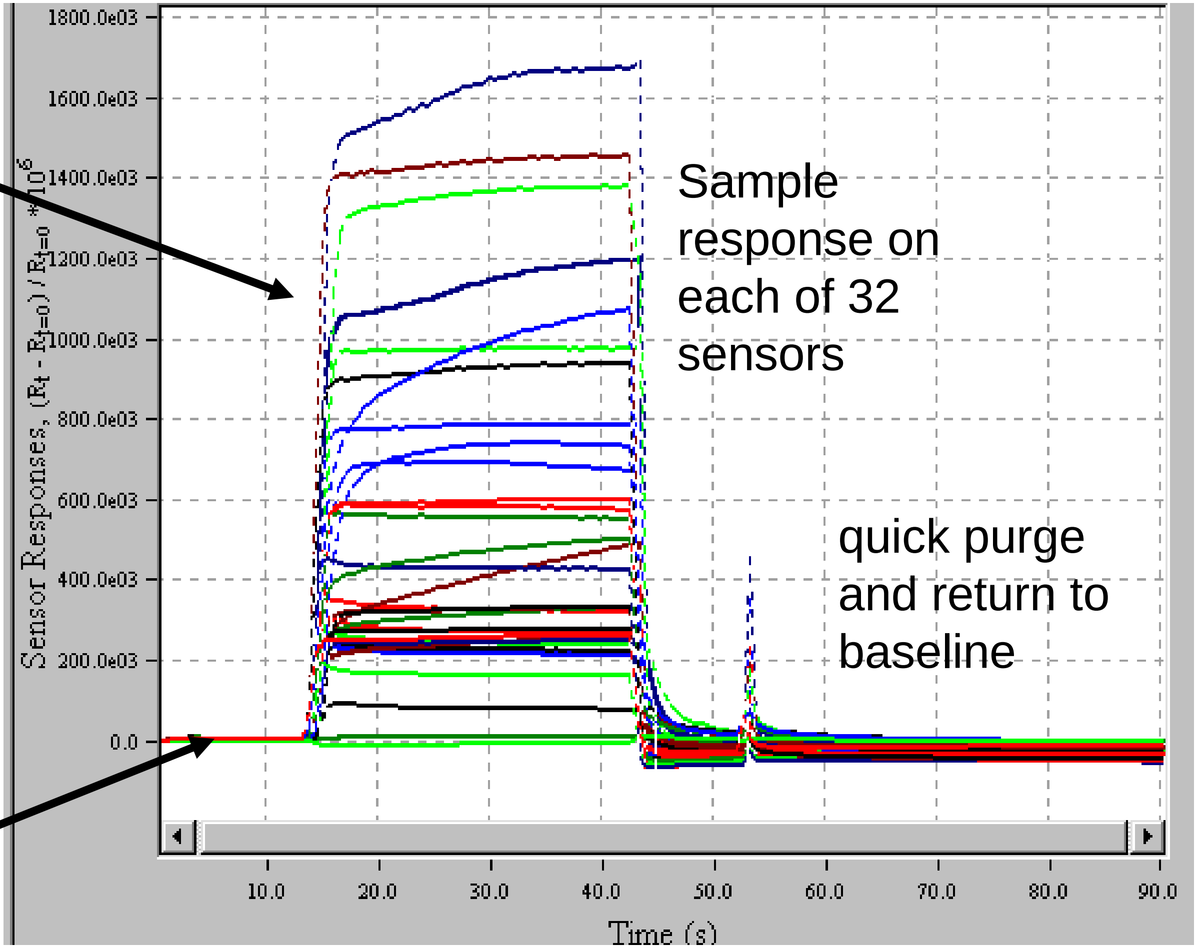
Cyranose 320 – Sensor Response



sample vapor

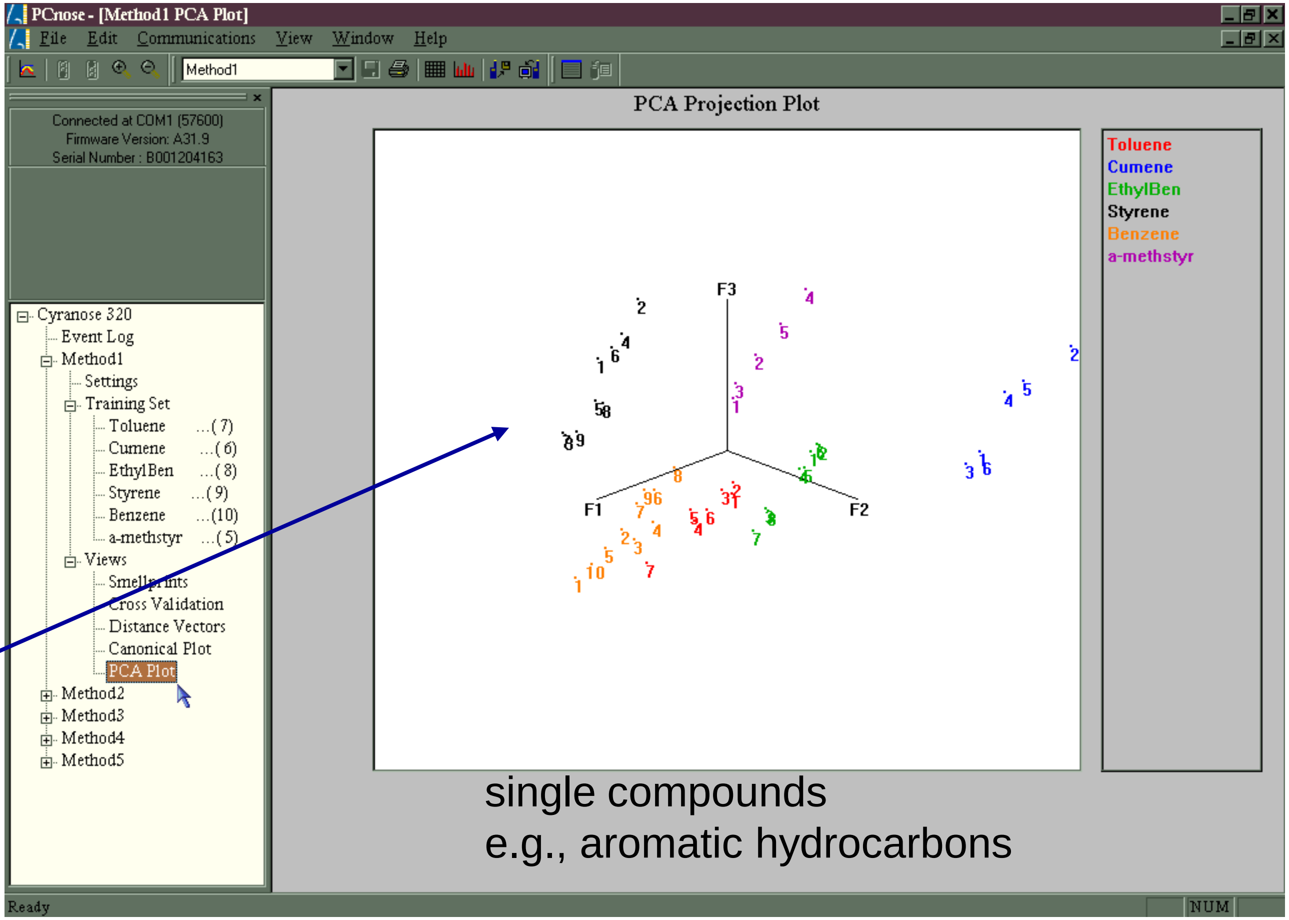
Sample response on each of 32 sensors

quick purge and return to baseline

constant baseline

Cyranose 320 – Data Visualization

- Smell prints
- Cross validation
- Distance vectors
- Canonical Plot
- PCA Plot



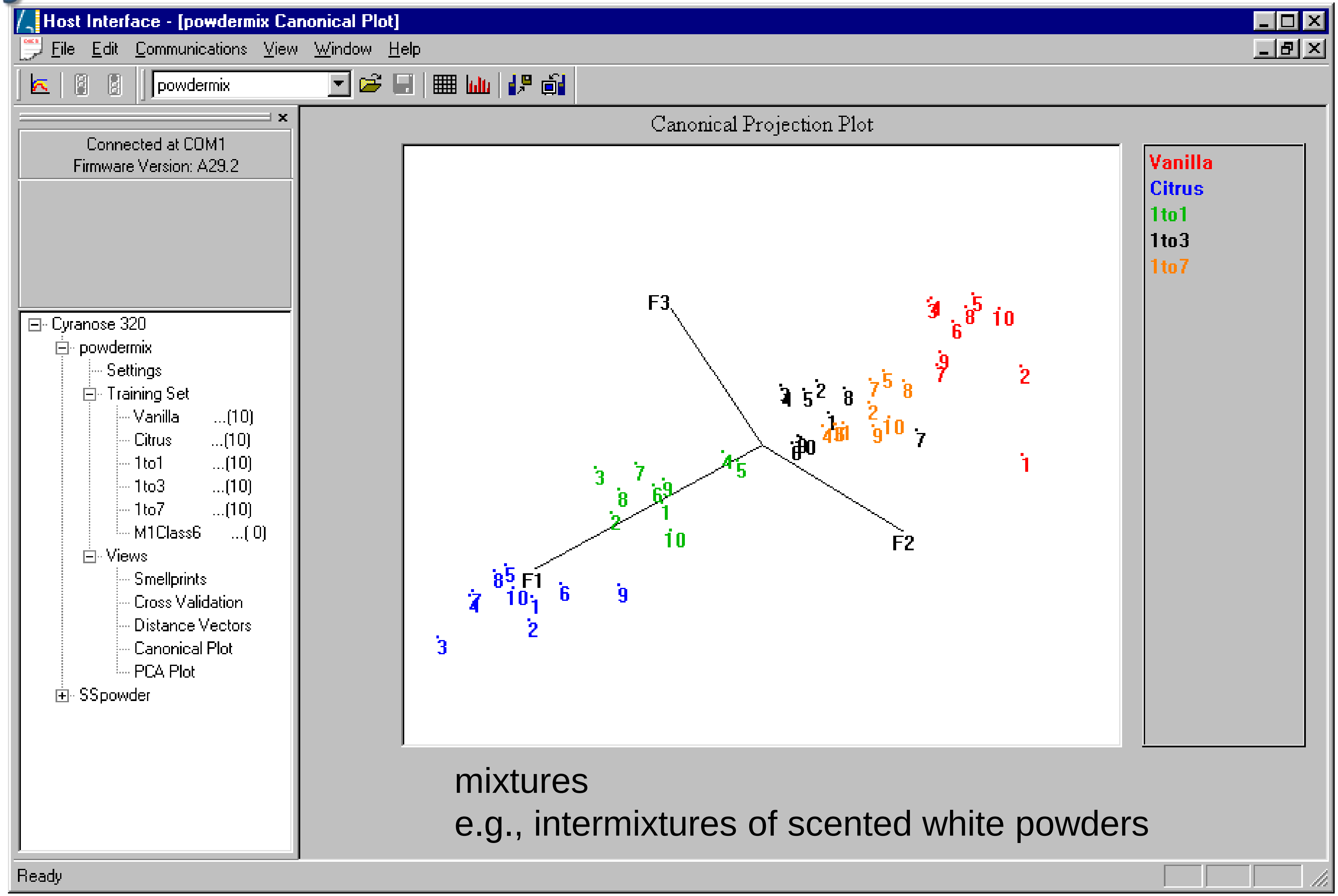
Connected at COM1 (57600)
Firmware Version: A31.9
Serial Number : B001204163

- Cyranose 320
  - Event Log
  - Method1
    - Settings
    - Training Set
      - Toluene ...(7)
      - Cumene ...(6)
      - EthylBen ...(8)
      - Styrene ...(9)
      - Benzene ...(10)
      - a-methstyr ...(5)
    - Views
      - Smellprints
      - Cross Validation
      - Distance Vectors
      - Canonical Plot
      - PCA Plot
  - Method2
  - Method3
  - Method4
  - Method5

Toluene
Cumene
EthylBen
Styrene
Benzene
a-methstyr

single compounds
e.g., aromatic hydrocarbons

Cyranose 320 – Data Visualization



Connected at COM1
Firmware Version: A29.2

- Cyranose 320
  - powdermix
    - Settings
    - Training Set
      - Vanilla ...(10)
      - Citrus ...(10)
      - 1to1 ...(10)
      - 1to3 ...(10)
      - 1to7 ...(10)
      - M1Class6 ...(0)
    - Views
      - Smellprints
      - Cross Validation
      - Distance Vectors
      - Canonical Plot
      - PCA Plot
  - SSpowder

Ready

mixtures

e.g., intermixtures of scented white powders

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Cyranose 320

Use Examples for Quality Assurance and Quality Control

- Incoming inspection and verification of bulk chemicals
- Confirmation of raw materials, ingredients
- Batch confirmation
- Process line change-over
- Product authentication
- Product quality, contamination and aging

Cyranose 320

Use Examples for Quality Assurance and Quality Control

- Incoming inspection and verification of bulk chemicals
  Example: printing solvents
- Confirmation of raw materials, ingredients
- Batch confirmation
- Process line change-over
- Product authentication
- Product quality, contamination and aging

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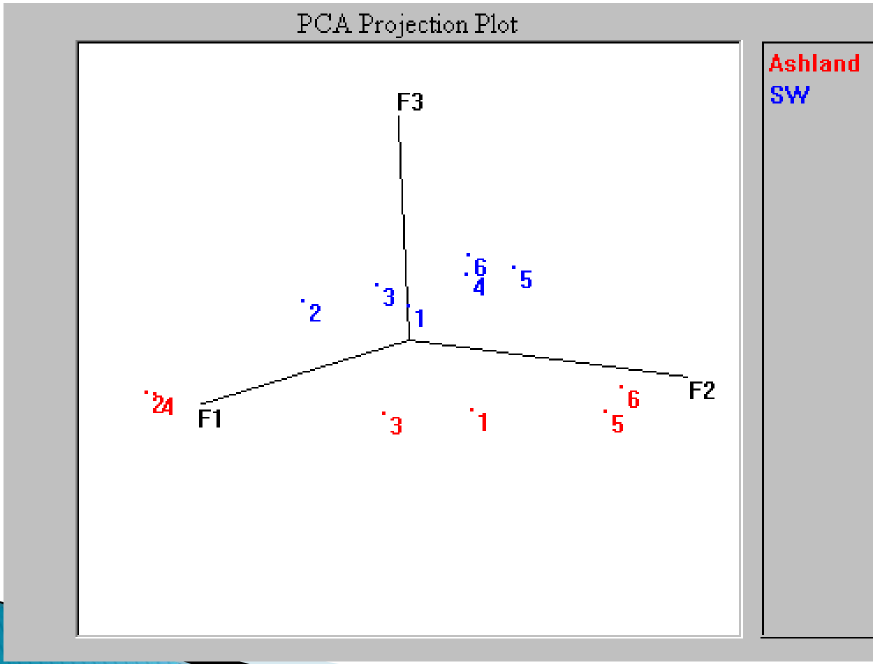
Incoming Inspection: Printing Solvents

PROBLEM:

A customer prints plastic bags and films using a variety of solvent blends depending on the product and application. The customer buys solvent blends from a number of suppliers and sometimes finds contamination. Contamination may impart unacceptable flavor or odor to the retail packaged food product (cereal or chips). The customer desired a rapid test to identify "bad" blends from different suppliers. A Cyranose 320 was used to distinguish between the customer's good and bad product examples and to develop a reliable test for incoming bulk containers and elsewhere in production..

RESULT:

Two solvent blends from different suppliers were tested. Both were reported to be 85% n-propanol, 15% n-propyl-acetate with up to 1% isobutanol (contaminant). 6 samples of each blend were measured (**Ashland** and **SW**). These samples were used to train the Cyranose and additional samples of "good" or "bad" were measured as unknowns. The results show the blends were discriminated and all of the unknowns were identified correctly with a high quality rating (3 or 5 stars). This shows the inspection method is robust.



	Sample	Result	Star
1	good	good	*****
2	bad	bad	*****
3	good	good	*****
4	bad	bad	*****
5	good	good	*****
6	bad	bad	*****
7	good	good	*****
8	bad	bad	*****
9	good	good	*****
10	good	good	***
11	good	good	*****
12	bad	bad	*****
13	bad	bad	***
14	bad	bad	*****
15	good	good	*****
16	bad	bad	*****
17	good	good	*****

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Cyranose 320

Use Examples for Quality Assurance and Quality Control

- Incoming inspection and verification of bulk chemicals
- Confirmation of raw materials, ingredients
  Example: soap fragrances
- Batch confirmation
- Process line change-over
- Product authentication
- Product quality, contamination and aging

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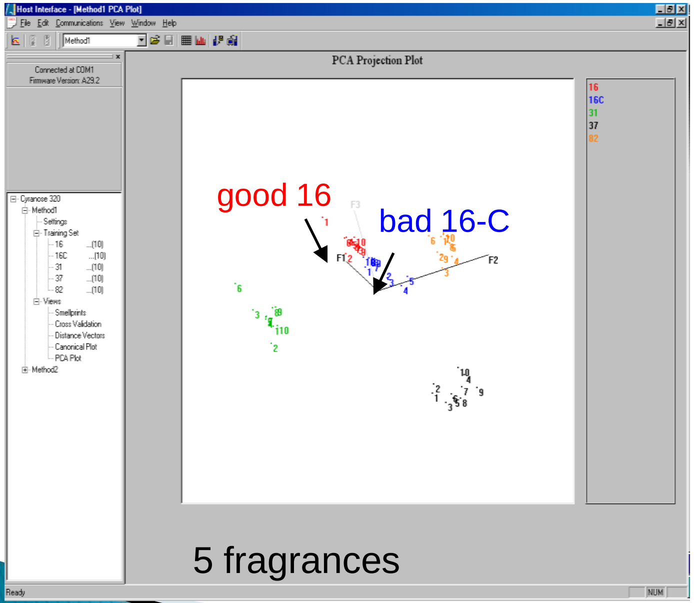
Incoming Inspection: Soap Fragrances

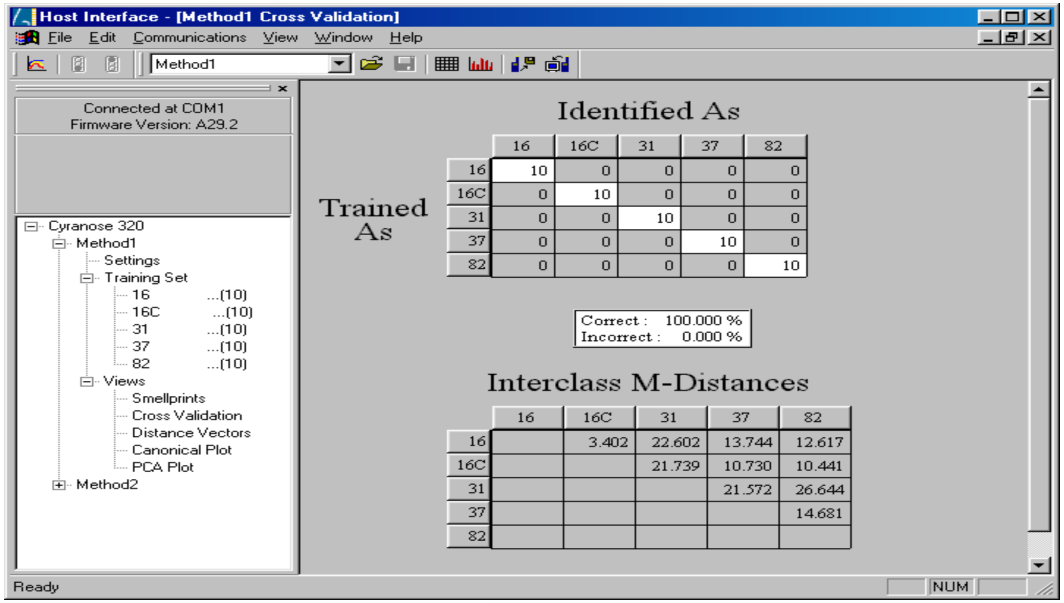
PROBLEM:

A consumer products company is seeking a portable means for inspecting raw materials and formulation of product ingredients. The customer buys or prepares fragrances for its bar soap products and desires a means to confirm the correct fragrance was purchased and that the correct fragrance was used in each soap formulation. A Cyranose 320 was used to distinguish between the customer's fragrance samples and to develop a reliable test for inspection of incoming bulk containers and elsewhere in production.

RESULT:

Nine fragrance samples were supplied and tested, including 8 good fragrances (**902316**, **807231**, **807137**, **902382**, **Tone**, **Dial**, **Crystal Breeze**, **Spring**) and one identified as contaminated (**902316-C**). A small amount (0.1ml) of each fragrance was placed in a 40ml glass vial; 10 replicates of each were prepared. The samples were tested in random sequence. This data formed a training set. Select samples were then re-tested daily for a period of 8 days. All 9 fragrance samples were easily discriminated (M-distance ranging from 10.7 to 33.3), including the contaminated sample 16-C.





Identified As

Trained As

	16	16C	31	37	82
16	10	0	0	0	0
16C	0	10	0	0	0
31	0	0	10	0	0
37	0	0	0	10	0
82	0	0	0	0	10

Correct : 100.000 %
Incorrect : 0.000 %

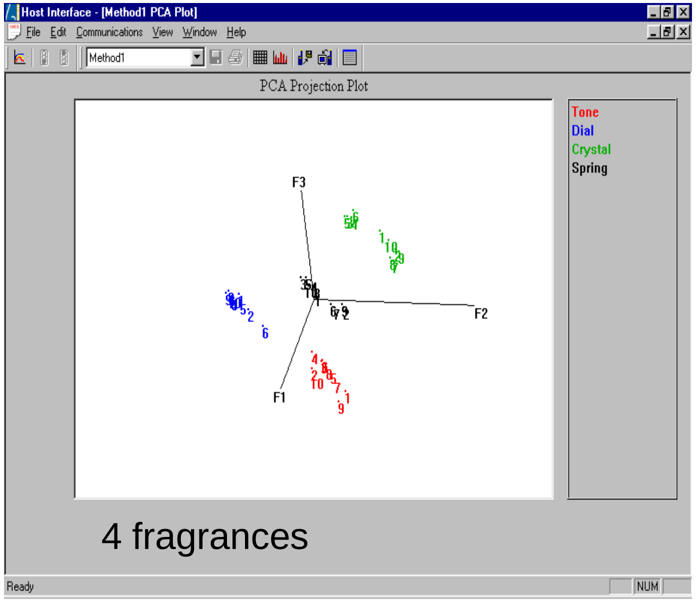
Interclass M-Distances

	16	16C	31	37	82
16		3.402	22.602	13.744	12.617
16C			21.739	10.730	10.441
31				21.572	26.644
37					14.681
82					

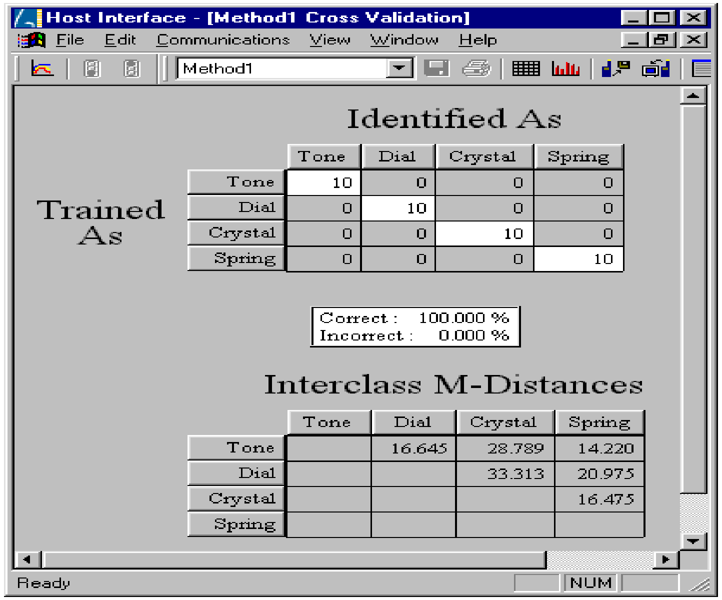
Incoming Inspection: Soap Fragrances

RESULT (continued):

All 9 fragrance samples were easily discriminated (M-distance ranging from 10.7 to 33.3).



4 fragrances



Identified As

Trained As	Tone	Dial	Crystal	Spring
Tone	10	0	0	0
Dial	0	10	0	0
Crystal	0	0	10	0
Spring	0	0	0	10

Correct : 100.000 %
Incorrect : 0.000 %

Interclass M-Distances

	Tone	Dial	Crystal	Spring
Tone		16.645	28.789	14.220
Dial			33.313	20.975
Crystal				16.475
Spring				

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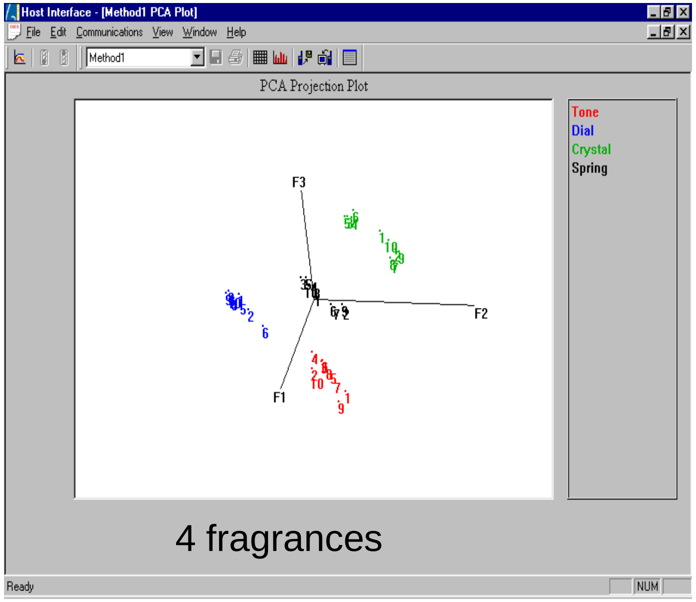
Incoming Inspection: Soap Fragrances

RESULT (continued):

6 samples of 4 selected fragrances were tested over 8 days. All of the samples were correctly identified each day with a 5-star quality indicator . No samples had a low rating and none were misidentified. This shows the inspection method is robust.



4 fragrances

(I) after 1day

	Tone	Dial	Crystal	Spring	Misidentified
Tone	6/6 *****				
Dial		6/6 *****			
Crystal			6/6 *****		
Spring				6/6 *****	

(ii) after 3 days

	Tone	Dial	Crystal	Spring	Misidentified
Tone	6/6 *****				
Dial		6/6 *****			
Crystal			6/6 *****		
Spring				6/6 *****	

(iii) after 7 days

	Tone	Dial	Crystal	Spring	Misidentified
Tone	6/6 *****				
Dial		6/6 *****			
Crystal			6/6 *****		
Spring				6/6 *****	

(iv) after 8 days

	Tone	Dial	Crystal	Spring	Misidentified
Tone	6/6 *****				
Dial		6/6 *****			
Crystal			6/6 *****		
Spring				6/6 *****	

Cyranose 320

Use Examples for Quality Assurance and Quality Control

- Incoming inspection and verification of bulk chemicals
- Confirmation of raw materials, ingredients
- Batch confirmation
  Examples: white candies, colored candies

  Examples: dairy products
- Process line change-over
- Product authentication
- Product quality, contamination and aging

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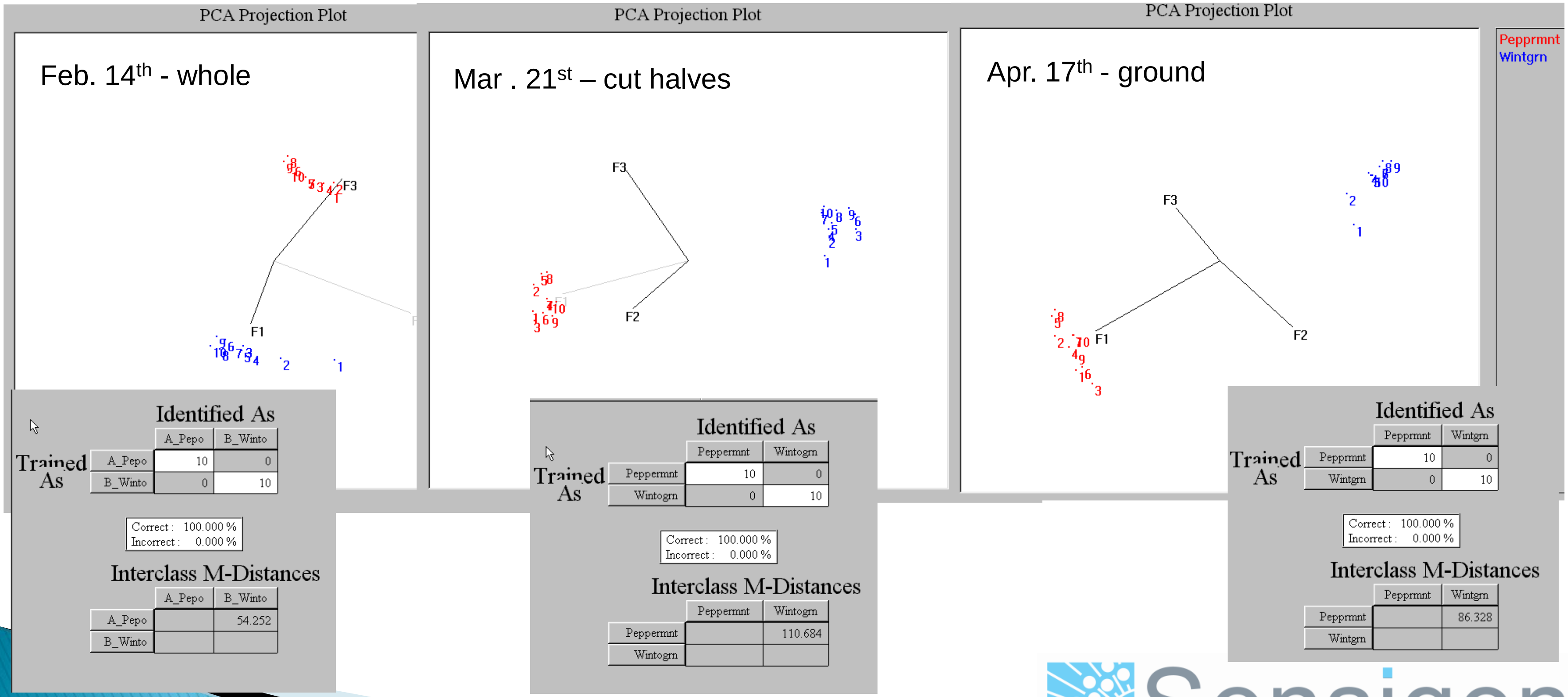
Batch Confirmation: White Candies

PROBLEM:

A candy company desired a test to confirm that the correct white mint candy was set up in its production or packaging line. The customer wanted a quick test that could be performed on “grab” samples pulled from the production or packaging line, particularly for candies that have identical appearance. A Cyranose 320 was used to distinguish between the customer’s samples and develop a test method for product confirmation that could be used daily or as needed by operations personnel.

RESULT:

10 samples of each candy were measured. Principal components analysis (PCA) shows wide discrimination of these related samples (M-distance over 50). The candies were tested over 2 months using the same instrument, testing different sample preparation methods, either whole, cut halves or grounded. In all cases the samples were easily discriminated.



		Identified As	
		A_Pepo	B_Winto
Trained As	A_Pepo	10	0
	B_Winto	0	10

Correct : 100.000 %
Incorrect : 0.000 %

Interclass M-Distances

	A_Pepo	B_Winto
A_Pepo		54.252
B_Winto		

		Identified As	
		Peppermnt	Wintogrn
Trained As	Peppermnt	10	0
	Wintogrn	0	10

Correct : 100.000 %
Incorrect : 0.000 %

Interclass M-Distances

	Peppermnt	Wintogrn
Peppermnt		110.684
Wintogrn		

		Identified As	
		Pepprmnt	Wintgrn
Trained As	Pepprmnt	10	0
	Wintgrn	0	10

Correct : 100.000 %
Incorrect : 0.000 %

Interclass M-Distances

	Pepprmnt	Wintgrn
Pepprmnt		86.328
Wintgrn		

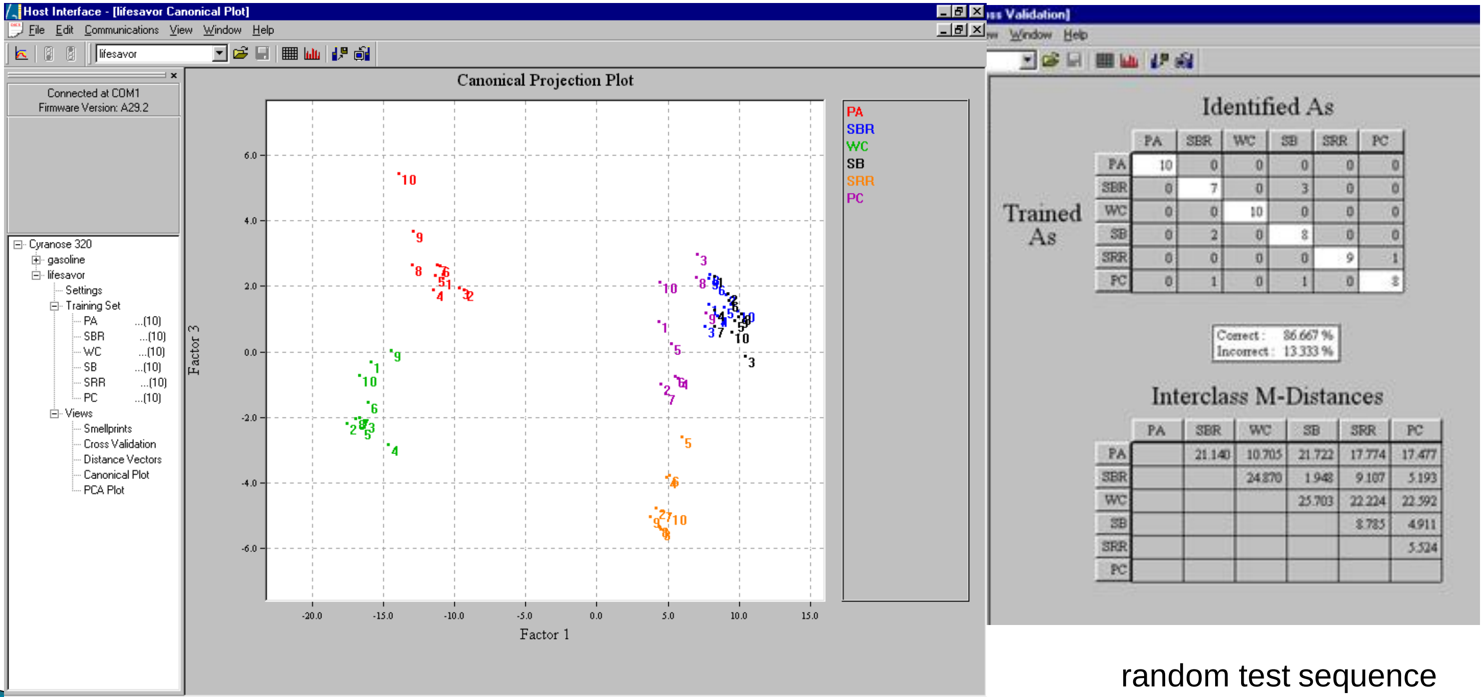
Batch Confirmation: Colored Candies

PROBLEM:

A candy company desired a test to confirm that the correct candy was set up in its production or packaging line. The customer wanted a quick test to confirm the correct candies were packaged together, particularly for candies that have the same color and appearance. A Cyranose 320 was used to distinguish between the customer's samples and develop a test method for product confirmation that could be used daily or as needed by operations personnel.

RESULT:

6 different flavors of candy were provided: 2 white (**pineapple, PA**; **pina colada, PC**), 2 red (**wild cherry, WC**; **sour red raspberry, SRR**) and 2 purple (**sour black raspberry, SBR**; **sour blackberry, SB**). Candy pieces were place in 40 ml glass vials for testing. 10 vials of each candy were tested (60 total) in a random sequence. All of the candies were easily discriminated except for the 2 purple candies (SB, SBR; M-distance 1.9). All of the candies are hygroscopic. When the humidity was controlled over the samples, and a drierite tube put on the inlet to the Cyranose, the discrimination improved.



Connected at COM1
Firmware Version: A29.2

- Cyranose 320
  - gasoline
  - lifesavor
    - Settings
    - Training Set
      - PA ...(10)
      - SBR ...(10)
      - WC ...(10)
      - SB ...(10)
      - SRR ...(10)
      - PC ...(10)
    - Views
      - Smellprints
      - Cross Validation
      - Distance Vectors
      - Canonical Plot
      - PCA Plot

Identified As

Trained As

	PA	SBR	WC	SB	SRR	PC
PA	10	0	0	0	0	0
SBR	0	7	0	3	0	0
WC	0	0	10	0	0	0
SB	0	2	0	8	0	0
SRR	0	0	0	0	9	1
PC	0	1	0	1	0	8

Correct : 86.667 %
Incorrect : 13.333 %

Interclass M-Distances

	PA	SBR	WC	SB	SRR	PC
PA		21.140	10.705	21.722	17.774	17.477
SBR			24.870	1.948	9.107	5.193
WC				25.703	22.224	22.592
SB					8.785	4.911
SRR						5.524
PC						

random test sequence

Test 1-30	Test 31-60
A	C
A	B
D	B
C	A
F	D
D	A
F	F
C	F
E	E
B	F
A	B
C	F
C	A
C	C
F	E
A	D
B	B
F	C
E	B
B	E
E	A
E	A
B	D
F	F
D	C
D	C
E	E
D	D
A	D
B	E

A – PA
B – SBR
C – WC
D – SB
E – SRR
F - PC

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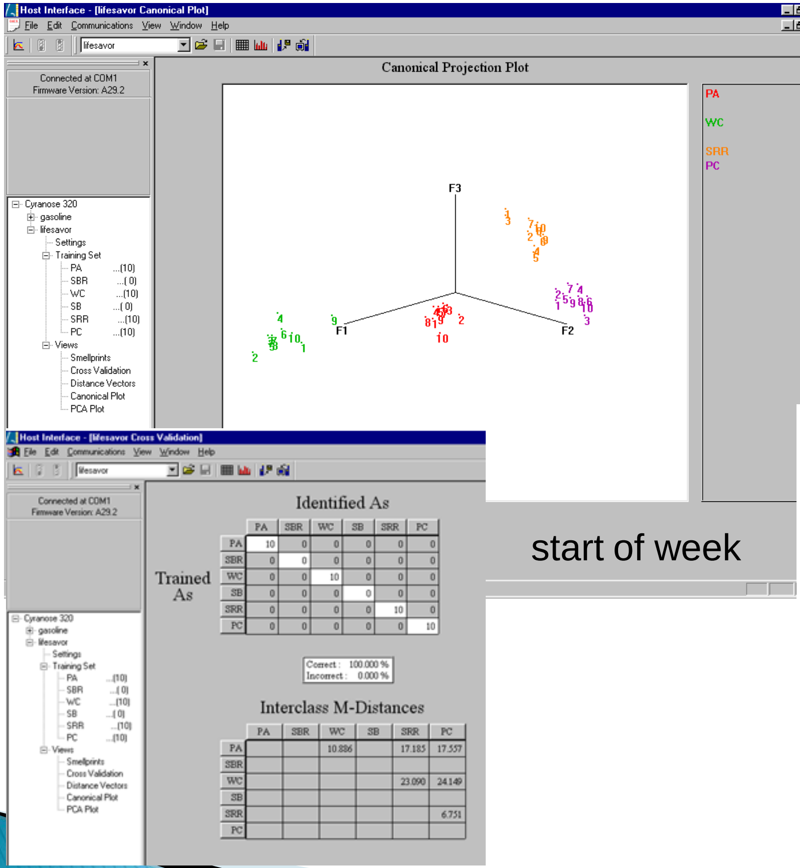
Batch Confirmation: Colored Candies

RESULT (continued):

The discrimination results for the 2 white (**pineapple, PA**; **pina colada, PC**) and 2 red (**wild cherry, WC**; **sour red raspberry**) candies was better than the purple candies. All of the samples were received in zip-lock bags from the customer and the bulk of the samples remained in the zip-lock bags during the tests. The 4 white and red candies were tested several times over the course of a week directly in the zip-lock bags without any humidity control. The results from the last test at the end of the week were similar to the first test at the beginning of the week, as shown by the CDA scores plot and measured by the M-distance values. The M-distances decreased during the week (PA-PC from 17 to 11, WC-SBR from 23 to 17) which may reflect changes in humidity inside the bags. This may be controlled by adding a silica gel or drierite pack.



Connected at COM1
Firmware Version: A29.2

Identified As

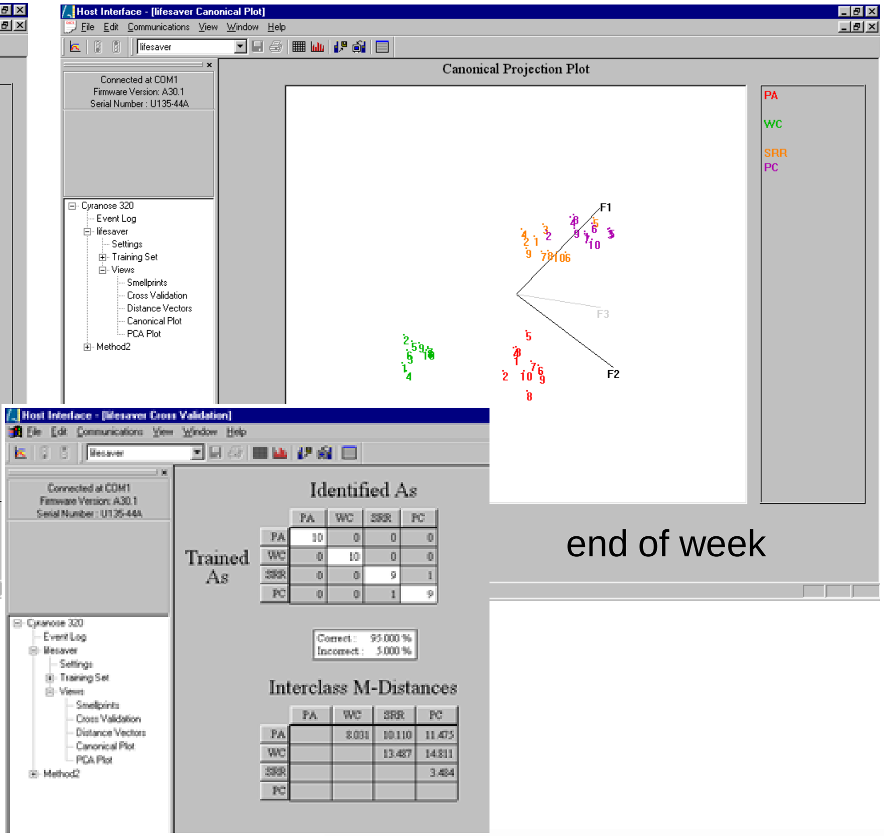
Trained As	PA	SBR	WC	SB	SRR	PC
PA	10	0	0	0	0	0
SBR	0	0	0	0	0	0
WC	0	0	10	0	0	0
SB	0	0	0	0	0	0
SRR	0	0	0	0	10	0
PC	0	0	0	0	0	10

Correct : 100.000 %
Incorrect : 0.000 %

Interclass M-Distances

	PA	SBR	WC	SB	SRR	PC
PA			10.886		17.185	17.557
SBR						
WC					23.090	24.149
SB						
SRR						6.751
PC						

start of week



Connected at COM1
Firmware Version: A30.1
Serial Number : U135-44A

Identified As

Trained As	PA	WC	SRR	PC
PA	10	0	0	0
WC	0	10	0	0
SRR	0	0	9	1
PC	0	0	1	9

Correct : 95.000 %
Incorrect : 5.000 %

Interclass M-Distances

	PA	WC	SRR	PC
PA		8.031	10.110	11.475
WC			13.487	14.811
SRR				3.484
PC				

end of week

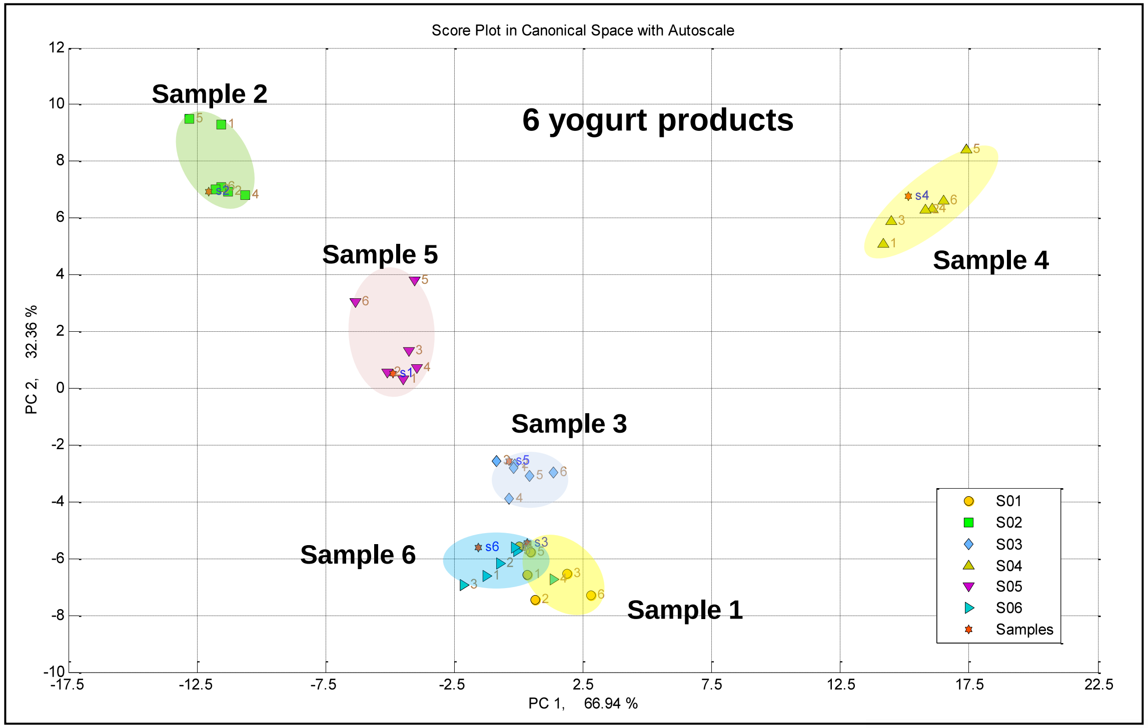
Batch Confirmation: Dairy Products

PROBLEM:

A dairy products company desired a test to confirm that the correct yogurt product was set up in its production or packaging line. The customer wanted a quick test that could be performed on “grab” samples pulled from the production or packaging line, particularly for yogurt products that have identical appearance (white) but different flavors, e.g., vanilla, banana, pineapple. A Cyranose 320 was used to distinguish between the customer’s samples and develop a test method for product confirmation that could be used daily or as needed by operations personnel.

RESULT:

5 yogurt products were provided and measured. Principal components analysis (PCA) shows wide discrimination of these related samples (M-distance over 20). A sample of each yogurt samples was tested again and each one correctly identified. The customer provided another yogurt product (number 6) and did not identify if it was the same or different than the others. The new sample #6 was tested and found to be very similar to Sample #1. The customer later confirmed it was the same as yogurt product #1.



Cyranose 320

Use Examples for Quality Assurance and Quality Control

- Incoming inspection and verification of bulk chemicals
- Confirmation of raw materials, ingredients
- Batch confirmation
- Process line change-over

  Example: bath and baby powders
- Product authentication
- Product quality, contamination and aging

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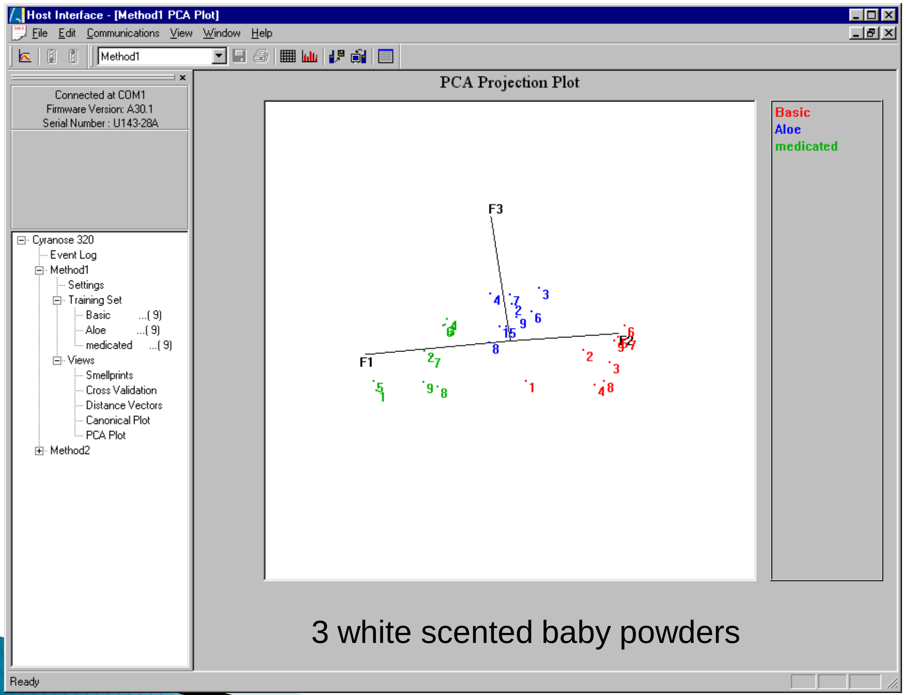
Process Line Change-Over: White Powders

PROBLEM:

A consumer products company desired a test to confirm that the correct scented white baby powder or scented white bath powder was set up in its production or packaging line. The customer wanted a quick test that could be performed on “grab” samples pulled from the production or packaging line. The customer also wanted to detect contamination or carryover from one powder production batch to another if the line wasn’t completely cleared out. A Cyranose 320 was used to distinguish between the customer’s samples and establish that carryover could be detected from one product to another product.

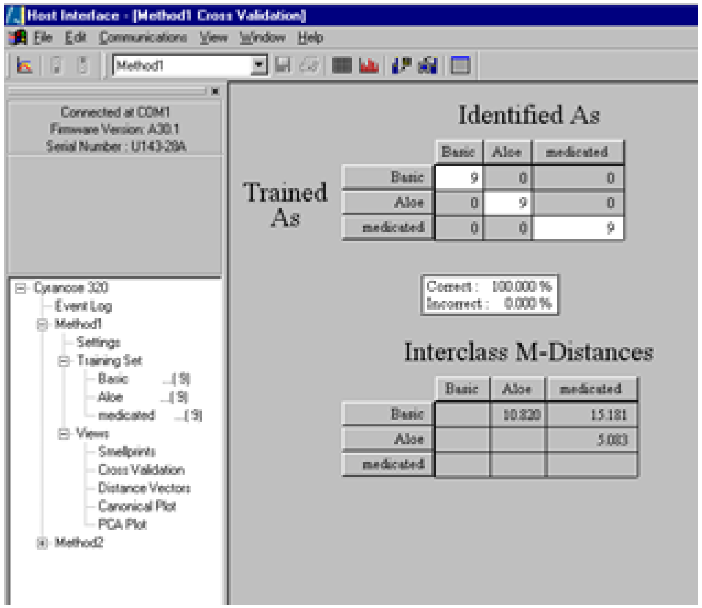
RESULT:

Three baby powders were supplied in plastic cups used to grab samples from the line. These were tested “as is” placing a kimwipe (paper towel) over the top of the powder to minimize uptake of particles. Two bath samples were supplied and these were used to make 5 intermixtures for testing (pure, 1:1, 1:3, 1:7, pure). Samples of each mixture were tested in glass vials in random sequence 10 times (50 total). The white baby powders were easily discriminated and the random samples of the bath powder mixtures were easily discriminated.



Connected at COM1
Firmware Version: A30.1
Serial Number : U143-28A

3 white scented baby powders



Connected at COM1
Firmware Version: A30.1
Serial Number : U143-28A

Identified As

Trained As	Basic	Aloe	medicated
Basic	9	0	0
Aloe	0	9	0
medicated	0	0	9

Correct : 100.000 %
Incorrect : 0.000 %

Interclass M-Distances

	Basic	Aloe	medicated
Basic		10.820	15.181
Aloe			5.083
medicated			

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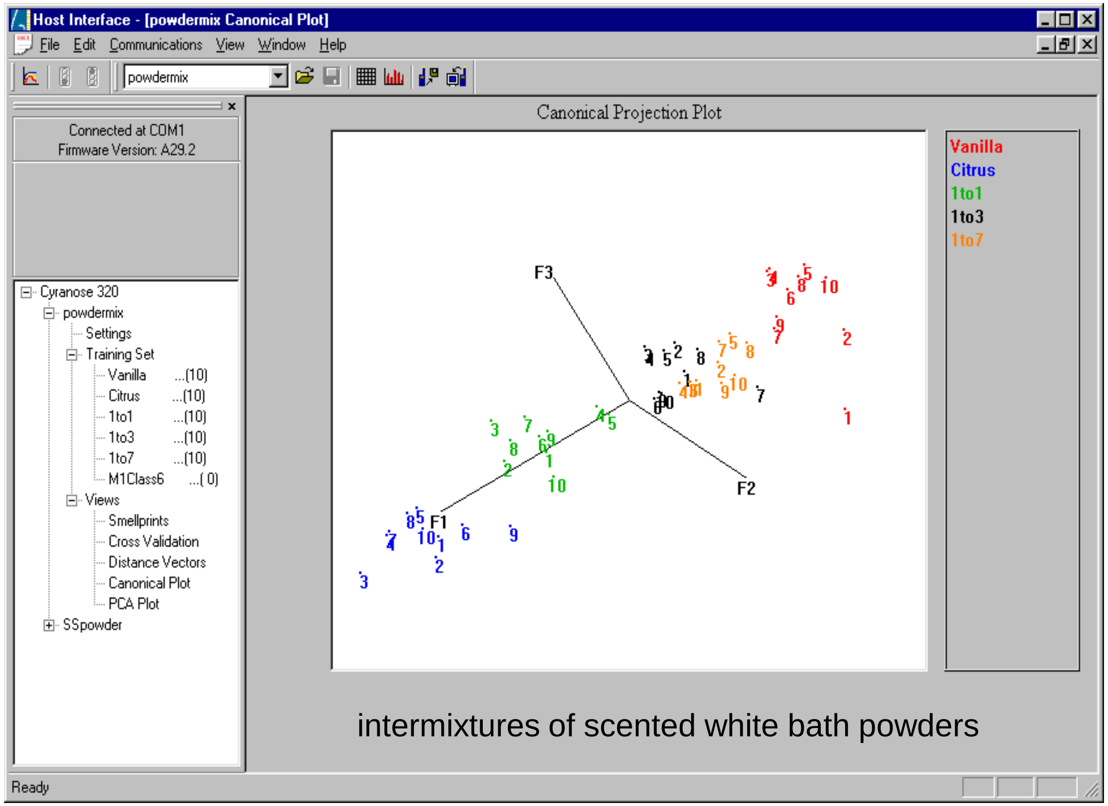
Process Line Change-Over: White Powders

RESULT (continued):

Two bath samples were supplied and these were used to make 5 intermixtures for testing (pure, 1:1, 1:3, 1:7, pure). Samples of each mixture were tested in glass vials in random sequence 10 times (50 total). The random samples of the bath powder mixtures were easily discriminated. The trend of the data showed the lowest concentration mixtures clustering nearest to the correct pure powder (**red, vanilla**).



Connected at COM1
Firmware Version: A29.2

Ready

intermixtures of scented white bath powders

Sample Class	Repeat Number	Sample Class	Repeat Number
A	1	C	6
A	2	B	6
D	1	B	7
C	1	A	6
D	2	D	6
C	2	A	7
E	1	E	6
B	1	B	8
A	3	A	8
C	3	C	7
C	4	E	7
C	5	D	7
A	4	B	9
B	2	C	8
E	2	B	10
B	3	E	8
E	3	A	9
E	4	A	10
B	4	D	8
D	3	C	9
D	4	C	10
E	5	E	9
D	5	D	9
A	5	D	10
B	5	E	10

random test sequence

A – Vanilla
B – Citrus
C – 1 to 1
D – 1 to 3
E – 1 to 7

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Cyranose 320

Use Examples for Quality Assurance and Quality Control

- Incoming inspection and verification
- Ingredient confirmation
- Batch confirmation
- Process line change-over
- Product authentication

  Example: Coke vs. other colas
- Product quality, contamination and aging

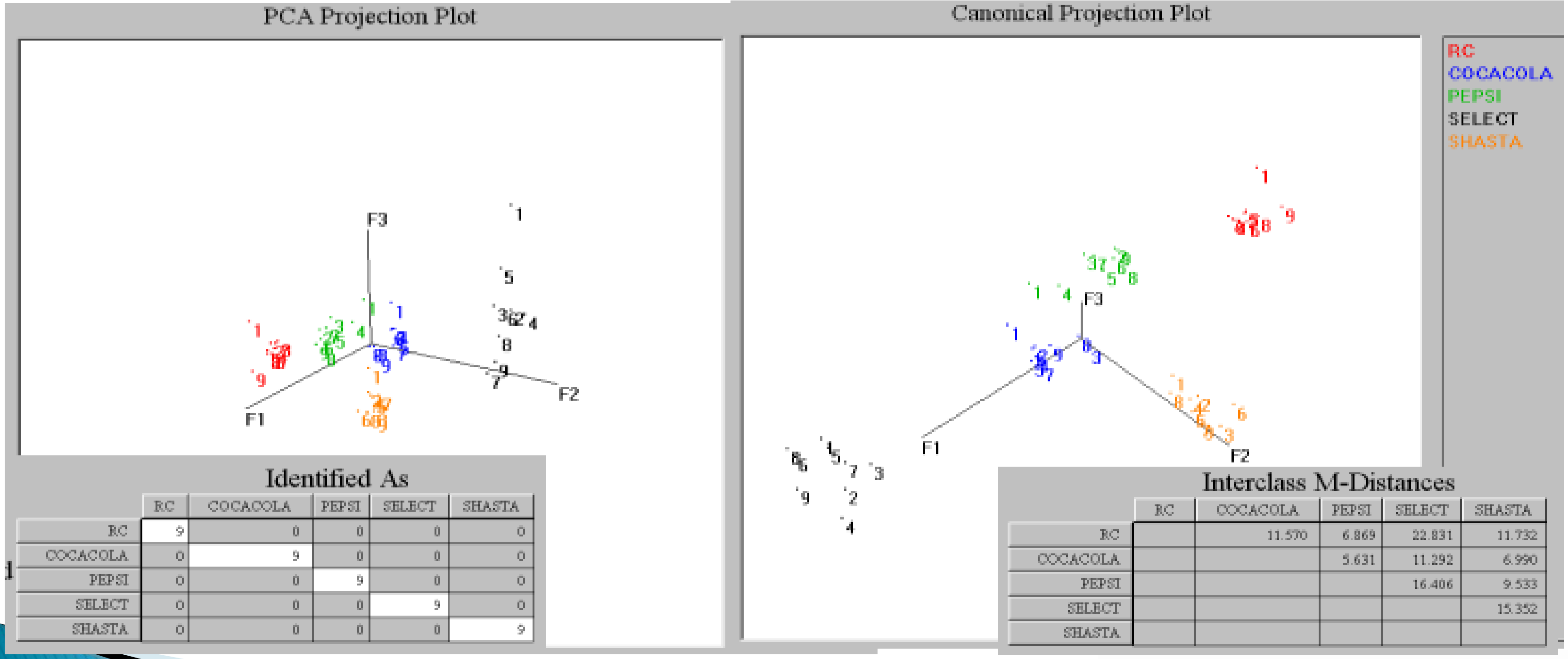
Product Authentication: Cola Beverages

PROBLEM:

A customer desired a test to determine whether the correct cola product (syrup) was being used throughout its bottling plants and at retail locations. The premium product (Coca-cola) is similar in appearance and other characteristics to non-premium products such as RC, Select, Shasta and other competing premium products (Pepsi). A Cyranose 320 was used to distinguish between the customer's product and other similar products and develop a test method for product authentication. The customer desired a test that could be applied rapidly by field service personnel at retail locations as well as the audit team at bottling plants.

RESULT:

9 samples of each cola were measured (**RC**, **Coke**, **Pepsi**, **Select**, **Shasta**). Principal components (PCA) and canonical discriminant (CDA) analysis show clear discrimination of these related samples (M-distance 5.6 to 22.8). Each sample was identified as belonging to the correct group which shows the authentication method is robust.



Identified As

	RC	COCACOLA	PEPSI	SELECT	SHASTA
RC	9	0	0	0	0
COCACOLA	0	9	0	0	0
PEPSI	0	0	9	0	0
SELECT	0	0	0	9	0
SHASTA	0	0	0	0	9

Interclass M-Distances

	RC	COCACOLA	PEPSI	SELECT	SHASTA
RC		11.570	6.869	22.831	11.732
COCACOLA			5.631	11.292	6.990
PEPSI				16.406	9.533
SELECT					15.352
SHASTA					

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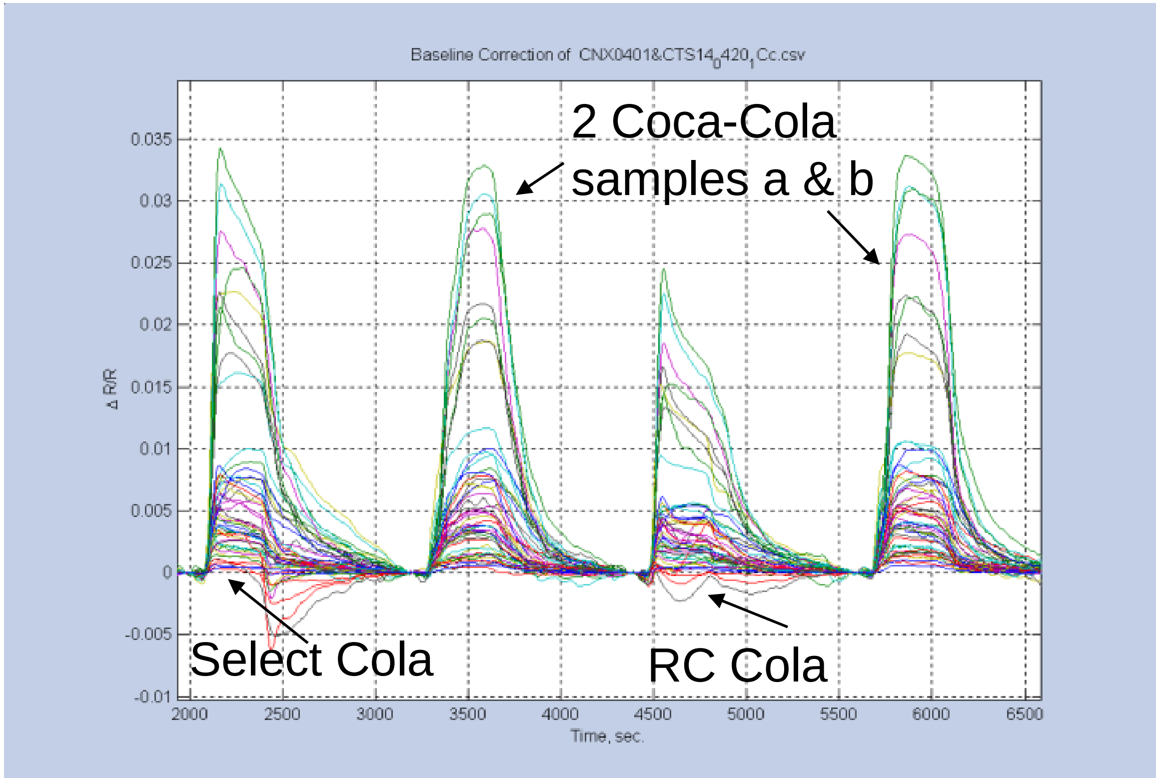
Product Authentication: Cola Beverages

RESULT (continued):

The differences between these related products was evident even in the raw response of most of the sensors on the array as shown below. Here the real-time response is functionally distinct for the premium product (Coke) as compared to the others (RC, Select). This dynamic response is not typically used in the discrimination analysis or in the calculation of the static response (∆R). Adding this dynamic information into the discrimination model (not shown) yields dramatic differences between the products.



2 Coca-Cola samples a & b

Select Cola

RC Cola

Cyranose 320

Use Examples for Quality Assurance and Quality Control

- Incoming inspection and verification
- Ingredient confirmation
- Batch confirmation
- Process line change-over
- Product authentication
- Product quality, contamination and aging

  Examples: peanuts, canned seafood,
  fresh packaged fruit, rice

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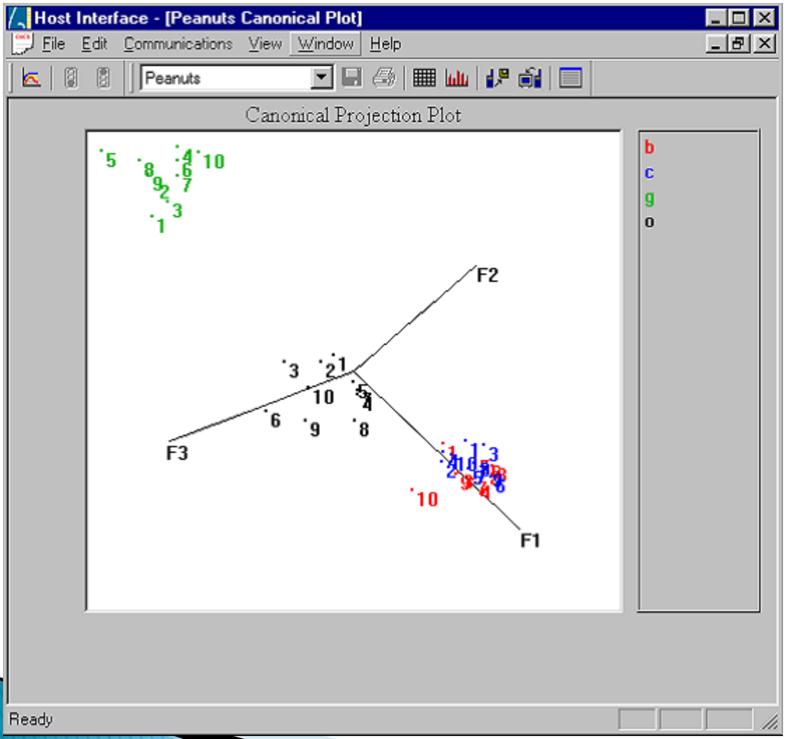
Product Quality: Roasted Peanuts

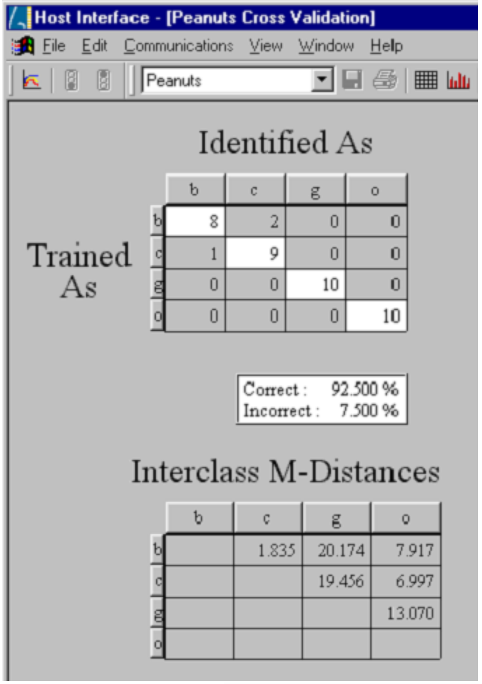
PROBLEM:

A food company desired a test to identify several instances of poor product quality resulting from the production process for their roasted peanuts product. The test would be performed by QA personnel in the lab initially and then transferred to production personnel. A Cyranose 320 was used to distinguish between customer samples of poor quality product.

RESULT:

Four samples of poor quality peanuts were provided in plastic bags labeled "Burnt/Bitter" (**red, b**), "Chemical/Plastic" (**blue, c**), "Green beany" (**green, g**) and "Oxidized" (**black, o**). Principal component analysis (PCA) shows distinct regions for each sample. The "burnt/bitter" and "chemical/plastic" samples were not fully resolved from one another. The customer supplied samples of acceptable product and additional testing over 4 weeks showed each of the 4 "bad" cases was easily identified and distinguished from the "good" product (data not shown). The customer was satisfied that all "bad" cases were differentiated from "good" and did not mind that 2 bad cases were not well-separated from one another.





Identified As

Trained As	b	c	g	o
b	8	2	0	0
c	1	9	0	0
g	0	0	10	0
o	0	0	0	10

Correct : 92.500 %
Incorrect : 7.500 %

Interclass M-Distances

	b	c	g	o
b		1.835	20.174	7.917
c			19.456	6.997
g				13.070
o				

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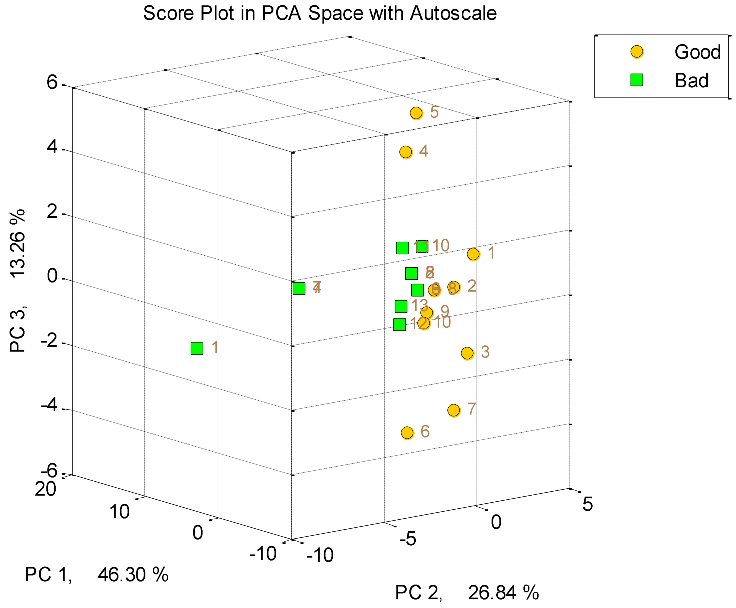
Product Quality: Frozen Canned Crab Meat

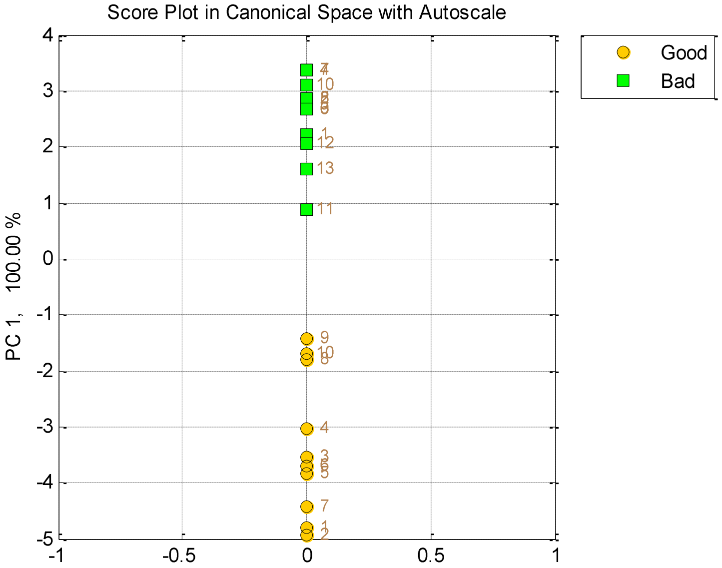
PROBLEM:

A customer desired a test to determine whether the quality of canned frozen crab meat had degraded or changed prior to thawing and mixing individual cans into large batches for processing. The test would be performed by persons upon opening the cans. A Cyranose 320 was used to distinguish between customer samples of good and bad frozen crab meat.

RESULT:

15 samples of each type were measured. A few pieces of meat were placed in glass vials to generate headspace and tested while still frozen. Principal component analysis (PCA) shows distinct regions for each type of meat and canonical discriminant analysis (CDA) and cross validation shows the Cyranose can identify good and bad crab meat.





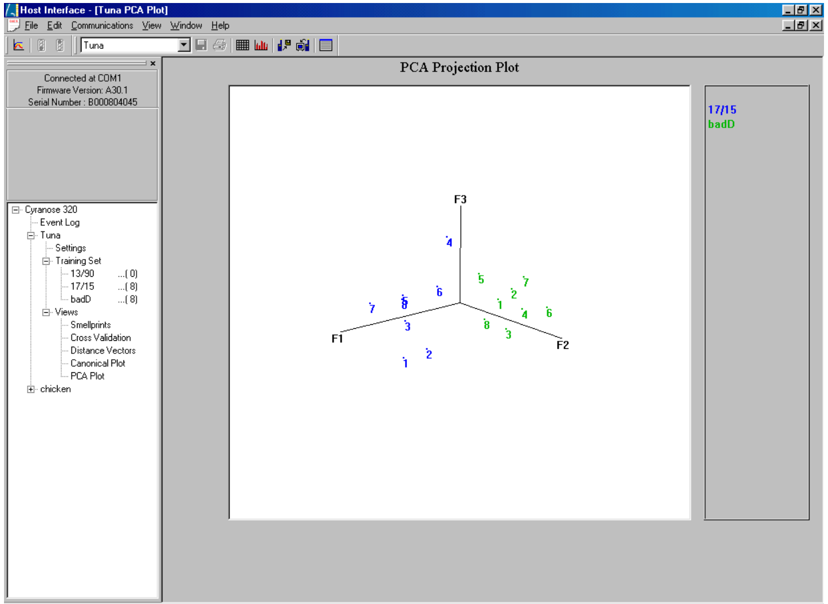
Product Contamination: Canned Tuna

PROBLEM:

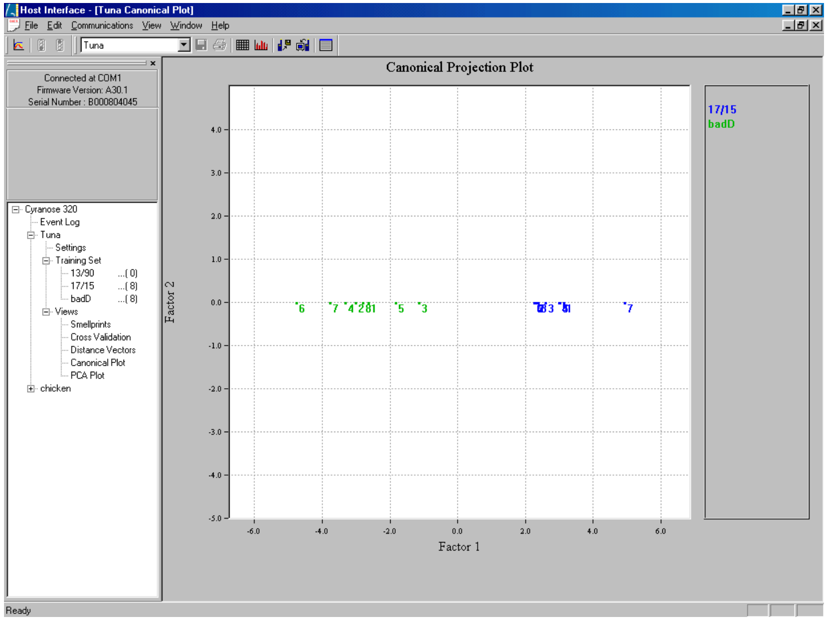
A customer desired a simple test to identify tuna that has become contaminated during processing, prior to blending and packaging the final product. During processing and cooking of the tuna, hydraulic fluid can seep into the tuna on occasion. This contamination causes an off-odor and poor taste for the final product. The amount of hydraulic fluid was measured by the customer using GC/MS and the measured amount was 60-63 ppb of the hydraulic fluid detected in the headspace. The Cyranose 320 was used to test customer samples of the packaged (canned) tuna with and without hydraulic fluid contamination.

RESULT:

8 samples of each type were measured. The Cyranose 320 was able to distinguish the contaminated tuna (**green, BadD**) from the non-contaminated tuna (**blue, 17/15**) in all cases as shown in the PCA scores plot. The CDA scores plot with cross validation shows the Cyranose can identify good and bad crab meat.



Connected at COM1
Firmware Version: A30.1
Serial Number : B000804045



Connected at COM1
Firmware Version: A30.1
Serial Number : B000804045

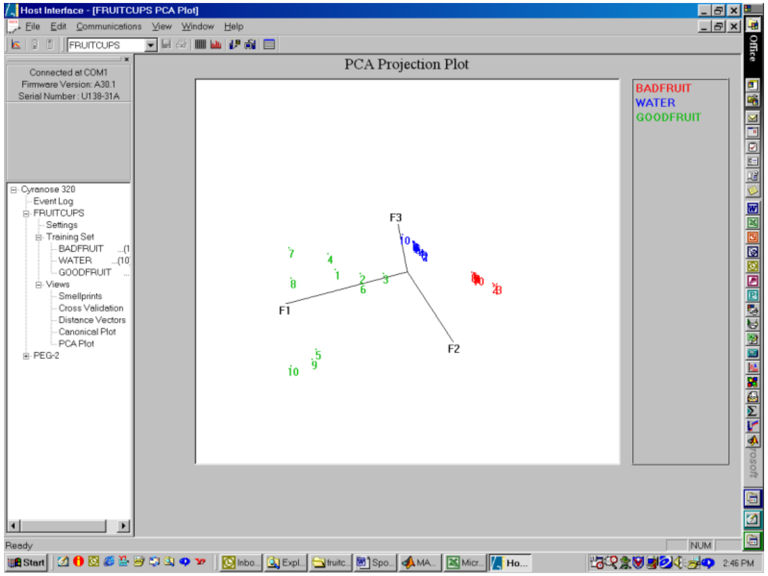
Product Contamination: Packaged Fruit Cups

PROBLEM:

A local food company produces fresh fruit products in sealed cups (fruit cups). If the seal or the lid of the fruit cup is compromised due to poor seal integrity or a pinhole leak, air intrusion results in fermentation and spoilage of the product. This is often not detected prior to delivery to the retail store or customer purchase. The food company provided examples of fresh and spoiled fruit cups for testing with the Cyranose 320 as a quality control tool for their products.

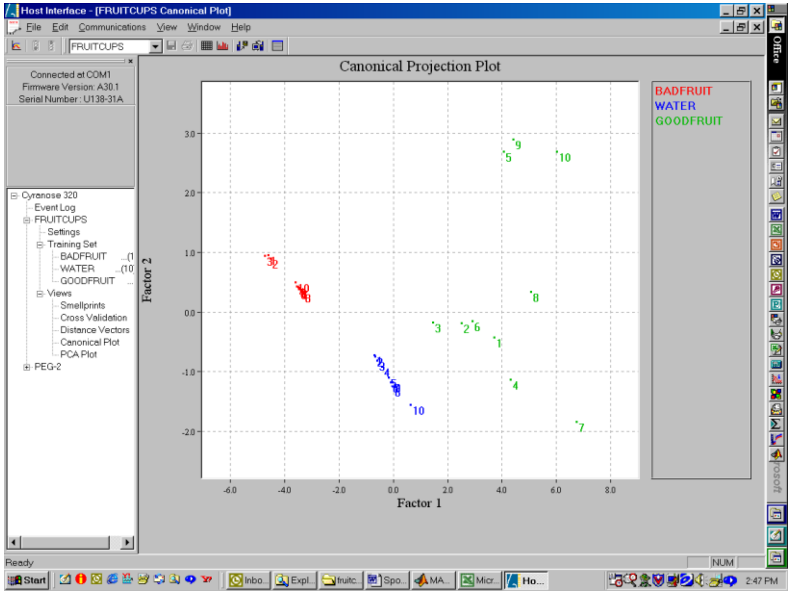
RESULTS:

10 samples of good product (**green, goodfruit**) and compromised/spoiled product (**red, badfruit**) were measured by sniffing around the lid of the fruit cups. Clear discrimination was obtained between the good and the bad fruit cups as shown in the PCA and CDA scores plots. The response from bad fruit cups is also different from pure water (**blue**), which confirms the Cyranose 320 is detecting the odor from bad fruit cups. The spread in the good fruit cup data indicates little or no odor was detected and the Cyranose was sampling air. Training to detect the bad odor resulted in highly accurate identification of bad fruit cups, with no misidentifications as good fruit cups.



Host Interface - [FRUITCUPS PCA Plot]

Connected at COM1
Firmware Version: A30.1
Serial Number : U138-31A



Host Interface - [FRUITCUPS Canonical Plot]

Connected at COM1
Firmware Version: A30.1
Serial Number : U138-31A

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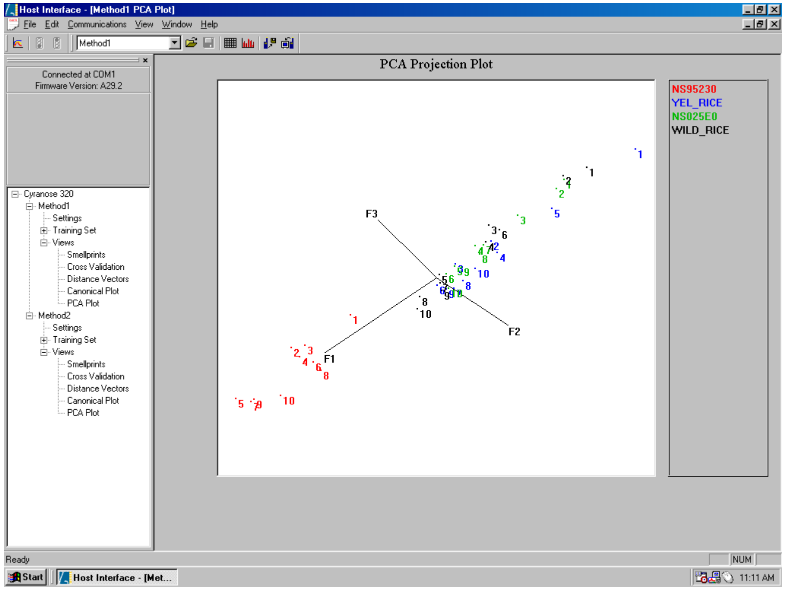
Product Aging: Rice

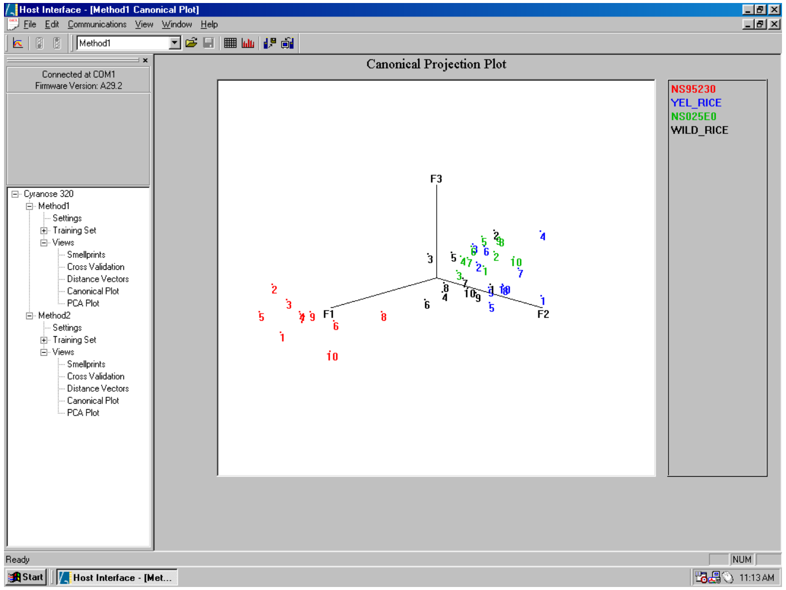
PROBLEM:

A customer was interested in understanding if the Cyranose 320 could help the quality assurance staff better detect aging in the company's rice product. Aged rice may have a change in aroma characteristic or taste, but the customer did not elaborate on the reasons for testing. The customer supplied four samples of rice for analysis for testing. The goal of the test was to distinguish the old rice from the new rice and supply the customer with the results whether or not the samples could be distinguished.

RESULT:

Rice samples were placed in glass vials for headspace measurement. The C320 was able to distinguish the aged rice sample (**red, ns95230**) from the other 3 rice samples. The other rice samples (**blue, yel_rice**; **black, wild_rice** and **green, ns025e0**) were not distinguished from one another. The analyst noted that none of the good samples or the aged sample had an obvious odor. The analyst noted that warming the vials to 40 or 50 degrees before testing would be advantageous to produce more headspace if separation of all 4 of the samples was desired.





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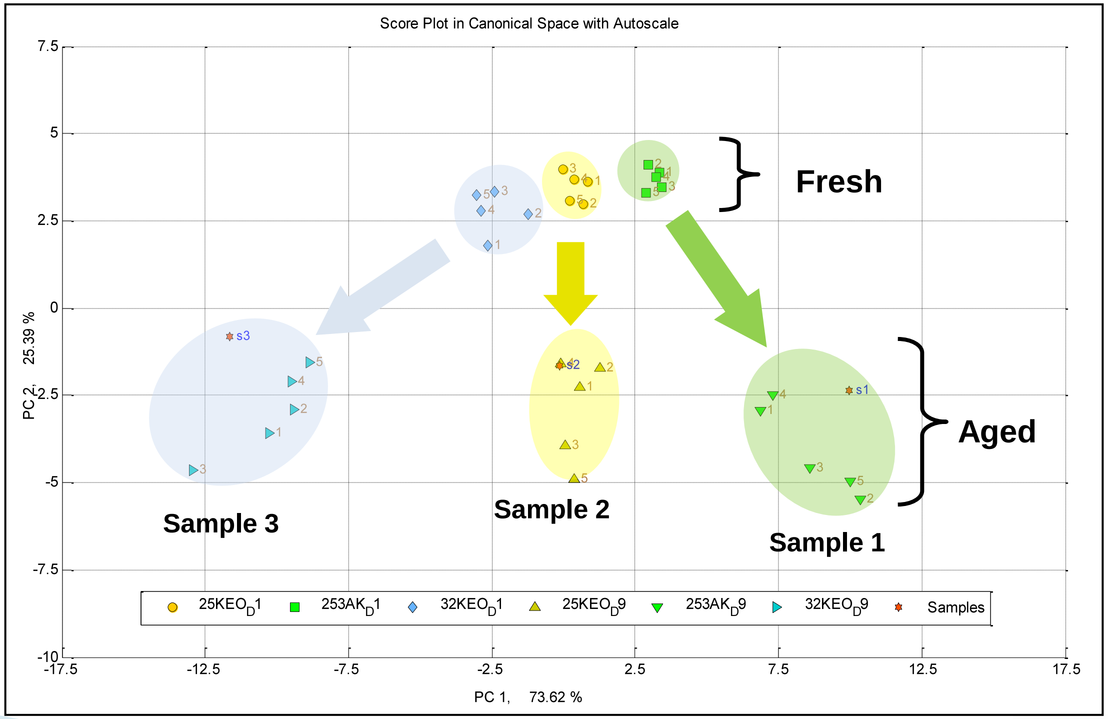
Product Aging: Milk-Based Dairy Products

PROBLEM:

A major dairy products manufacturer wanted to know if the Cyranose 320 could identify their different milk-based products (no flavor or aroma ingredients were added). The customer also wanted to know if the C320 could assist the quality assurance staff to detect aging in the company's milk-based products over time. The customer supplied three milk products for testing. The goal of the test was to distinguish the milk products and track them as they aged.

RESULT:

Milk samples were placed in glass vials for headspace measurement. The C320 was able to distinguish the fresh milk-based products from one another (Samples 1, 2 and 3). After storing the milk in a refrigerator for a few days at 4ºC / 38ºF the samples were tested again. Each aged milk product was identified correctly and the aged milk was also determined to have changed significantly from the original fresh product.



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For product information or to place an order, please contact:

Sensigent

sales@sensigent.com

626-768-2626

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