



# Colour Systems for the Analysis and Definition of Surface Texture, and its Effect on Colour Appearance

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Quantifying the effect of Texture  
on Colour Appearance



David P.Oulton, Elise Peterman  
& Andrew W. Bowen

Dept of Textiles UMIST 1998

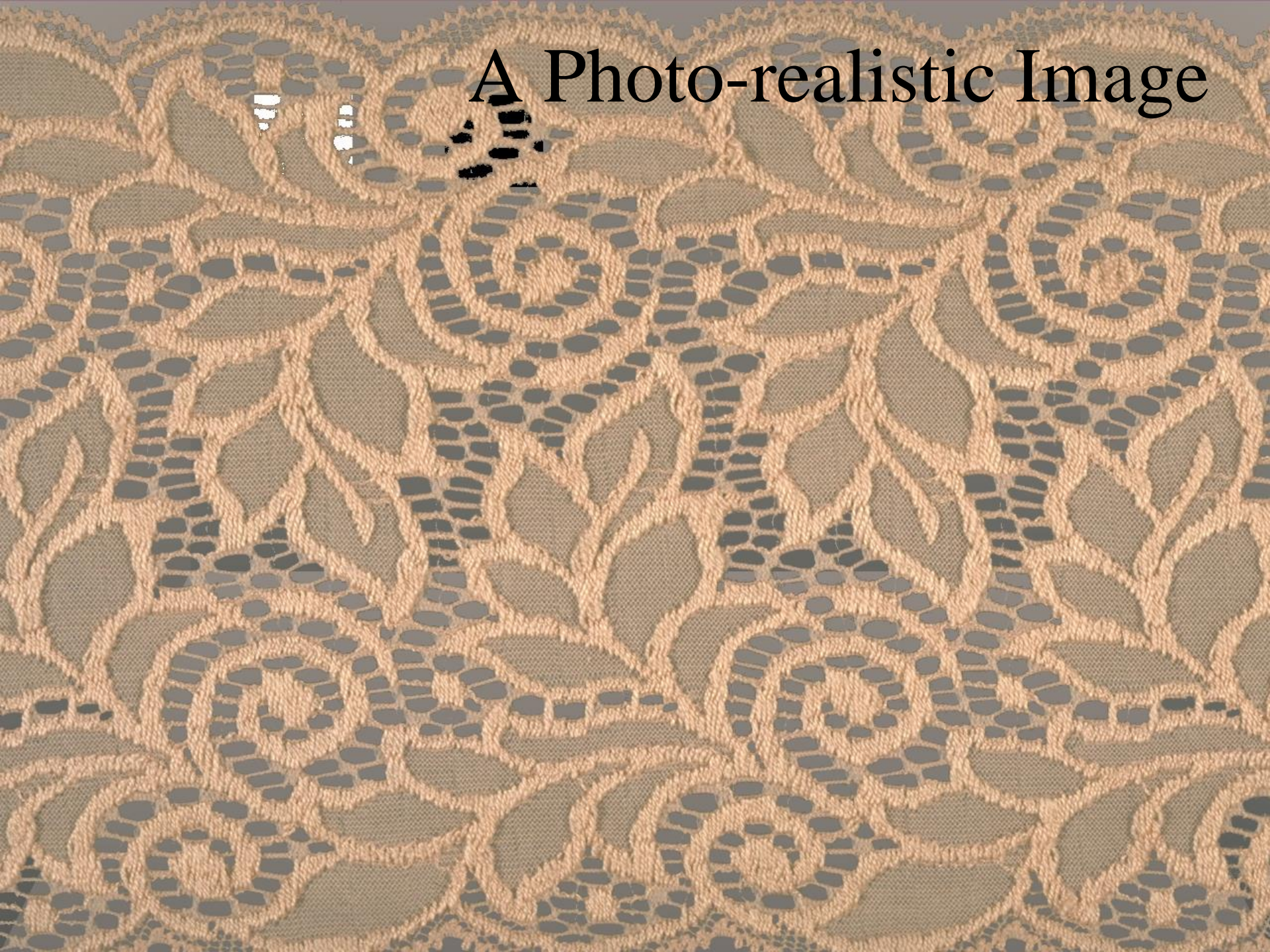
# Texture Rich Photo-Realistic Images

Contain :-

- The Micro-Level Colour Differences which represent Texture.
- Spatially distributed objects and object components.



A Photo-realistic Image





# A Different Type of Image



# Texture Rich Imaging Systems

- CIE Co-ordinate defined point-colour.
- The Micro-Level Colour Differences which represent Texture.
- The Contents of a Photo-Realistic Image.
- CIE Co-ordinate based Image Storage and Analysis Strategies.



# Image Analysis

- Logical Objects within Images have clearly defined easily separated Colour-Sets.
- The Key Discriminating Variable is Hue.
- Automatic Object Differentiation has proved to be highly effective, based on Delta H, Delta C and Delta L, using controlled band-widths.

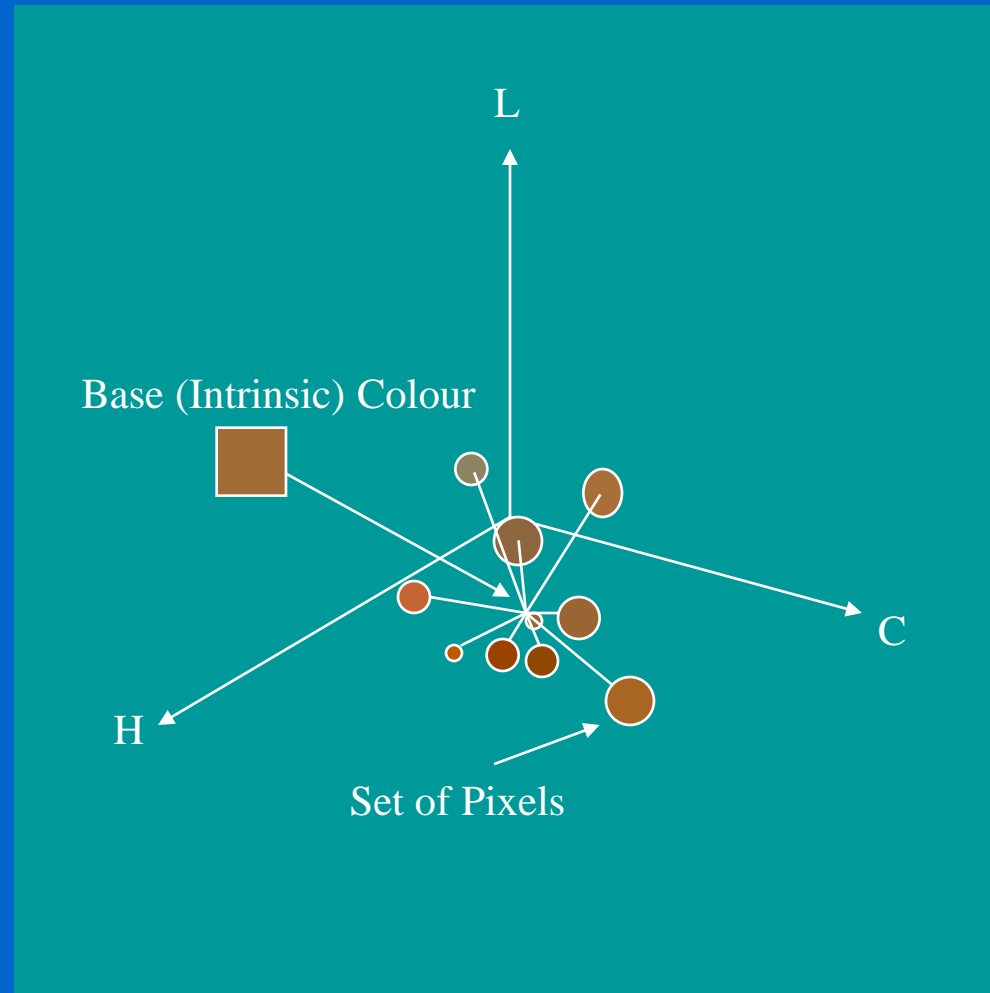


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## Colour-Set membership in a Vector Space

Each of several thousand colour definitions is represented, as a set of  $n$  pixels, at a distance  $H, C, L$  from the base-colour.

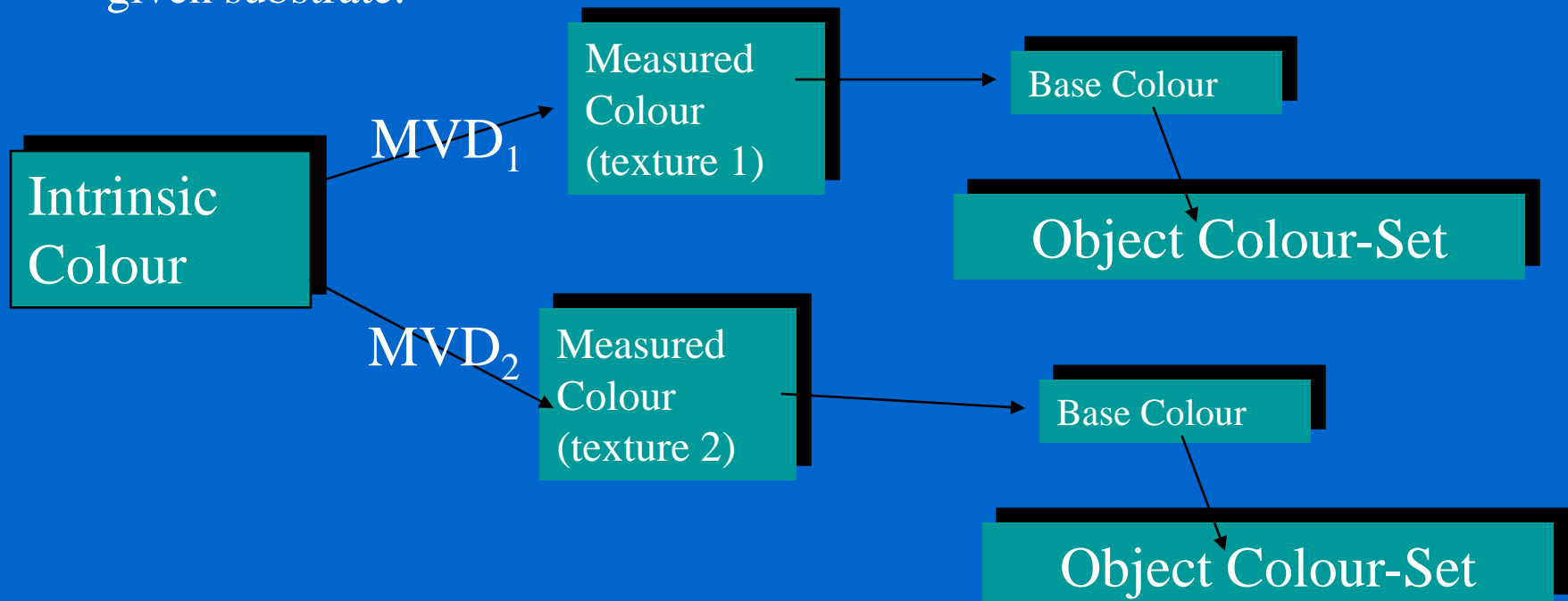
Point Colours Form a Variable Density Cloud, round the base-colour definition.





# Intrinsic Colour and Colour Appearance

- *Intrinsic colour* is defined as a central property of the colorants present (product colour specification).
- *Colour Appearance* is produced by applying the intrinsic colour to a given substrate.



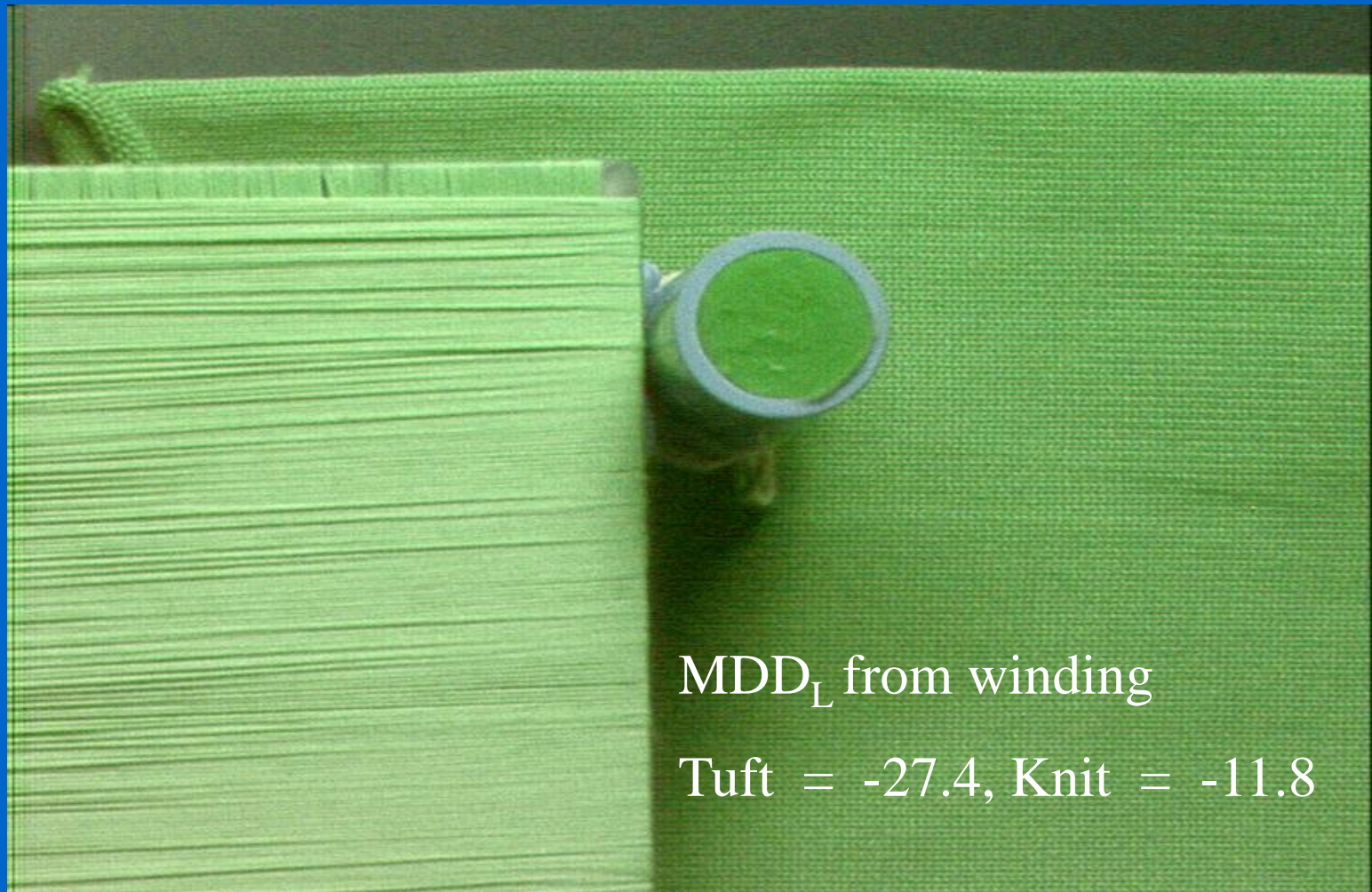
# Measures of Texture Appearance

**MCI (Mean Colour Identity)** reduces to a single colour identity the combined effects of an array of point-colour specifications.

**MDD values** express, for each dimension of colour difference, whether the texture appears lighter, darker, brighter, duller etc. than expected. They register and define *single dimensional displacements or deviations from some intrinsic colour definition*.

**An MVD value** expresses the vector displacement in three dimensions of colour-space that links intrinsic colour to colour appearance. The intrinsic colour from which the MVD is calculated may be a measured colour specification, or be derived by visual matching.

# Colour appearance variation



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## Deriving a value for Texture colour appearance

A single CIE colour specification (the MCI value) is calculated from many pixel colour specifications.

The pixel colour specifications come from a visually and numerically correct image of the texture.

A visually and / or numerically correct colour appearance is derived from a -

- Colour measurement (if the sample can be measured)

- A visual matching

- Calibration using a measured image-colour ‘hitching post’.





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## Validation using Imaged Textures

Observer trial validation was used to test for constant MVD with constant texture.

63 individual yarn winding samples widely distributed in colour-space have been shown to have an MVD of Zero to a common reference winding [EPSRC Final Report].

60 samples were made in three different textures, each texture was fabricated from a single yarn, using 20 different colours. The results are examined further in this account.

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# Yarn winding test colours



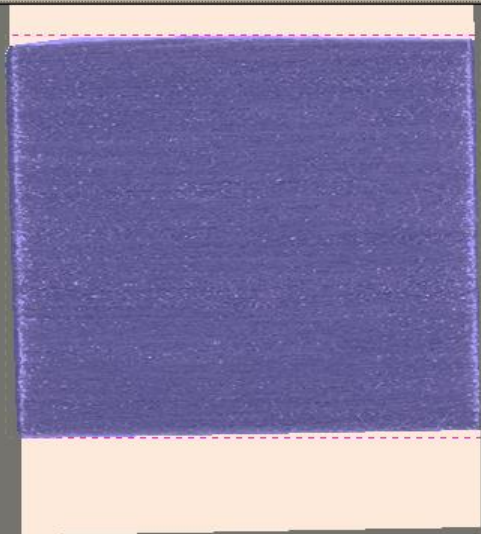
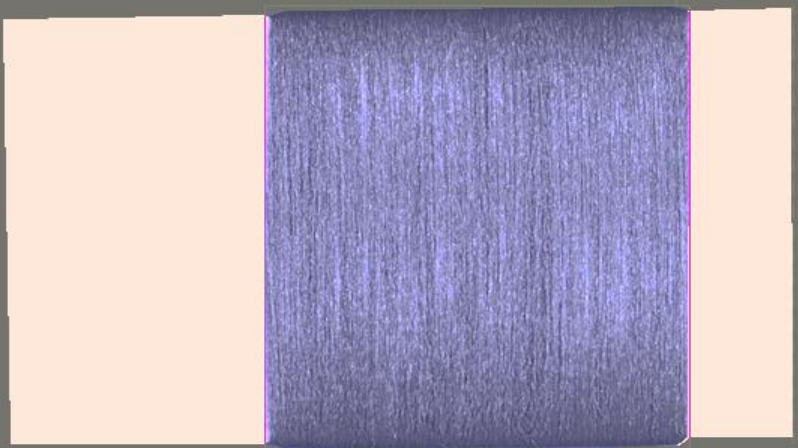
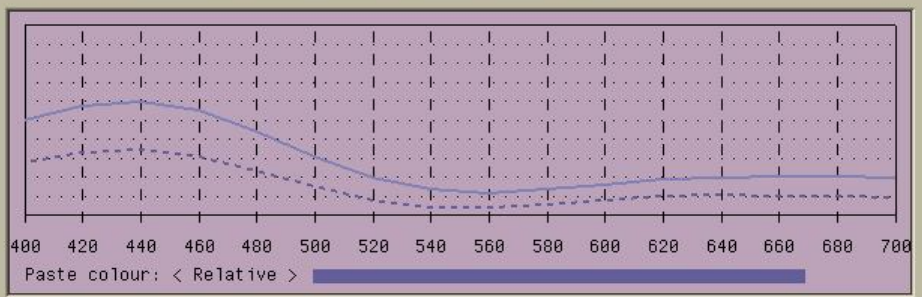
Monitor Calibration : Tue Nov 18 10:11:02 1997 (28 Days ago)  
 CRT Analyser : Minolta CA-100 on COM 1  
 Spectrophotometer : Minolta CM-2002 31 on COM 1  
 Curve generator : 16 Point - Boston D (Simple & Fast)  
 Multiple generators : Off - Only use Installed Generator  
 Gamut mapping is : On, Current Method Adjust Lightness and Chroma  
 Colour difference : Delta E (CIE Lab)  
 Base colour generator : histogram\_independent  
 All Selected Images Are Set To This.

Colour Change : Relative  
 Slaves In LCh Images : Processing Enabled  
 Approx. Memory Left : 27%

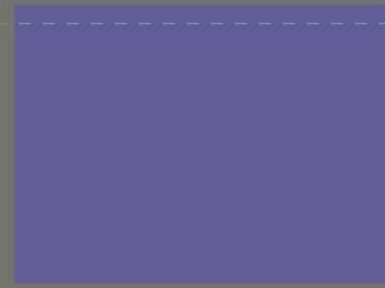
Selection : 2 Objects, All UnLocked

Standard Object : LCh Image, With 2 Sub-Objects

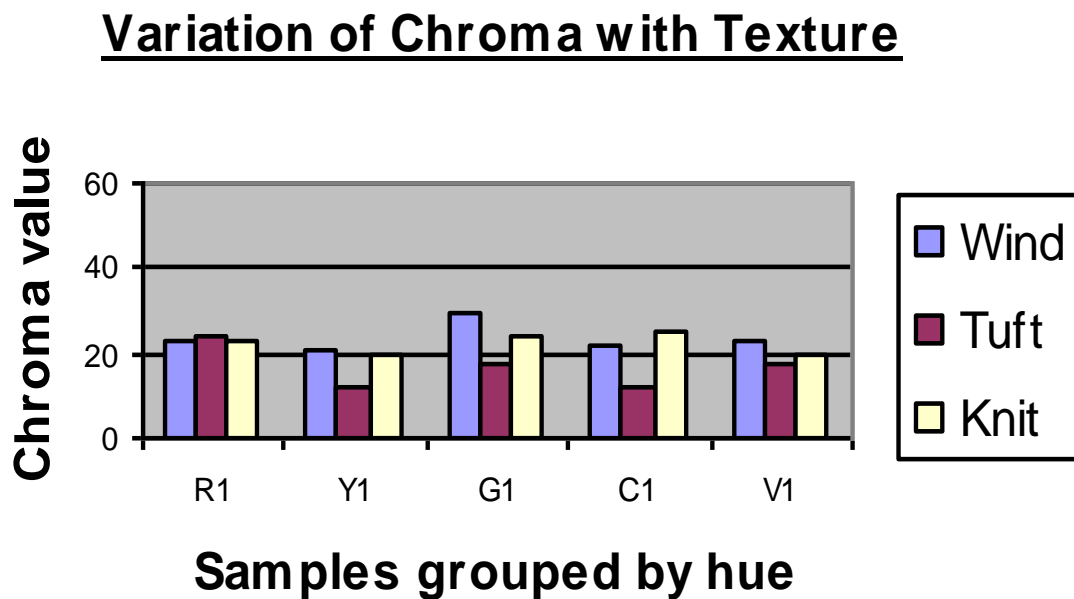
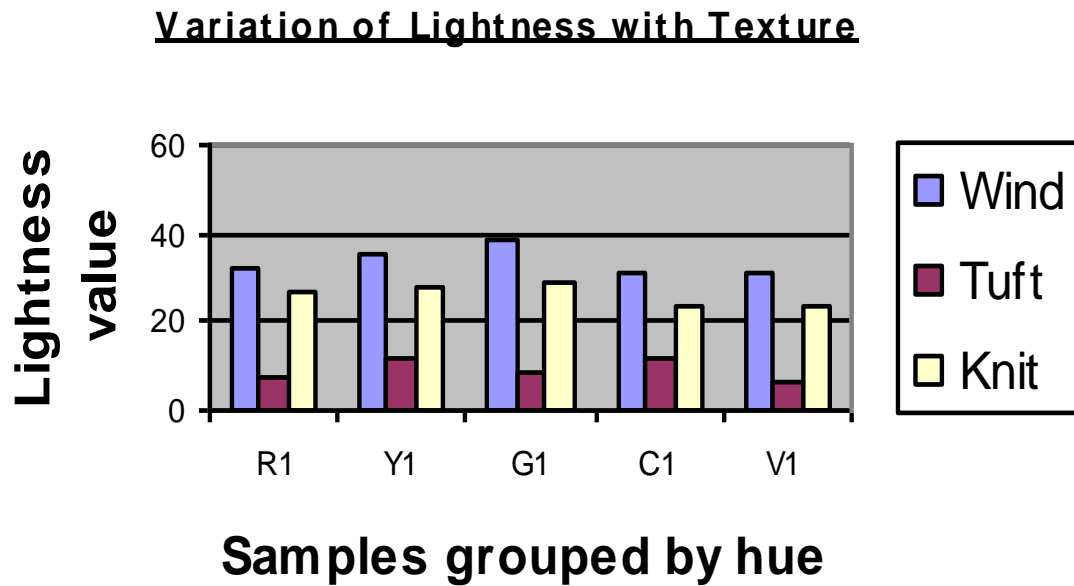
The Current Colour Environment is Under Illuminant D65 and Observer CIE 10 deg.  
 Environment File Name : < None >  
 Name : < None >  
 View Data : Scale 100.0% Center X 640 Y 512



Orientation  
Effects

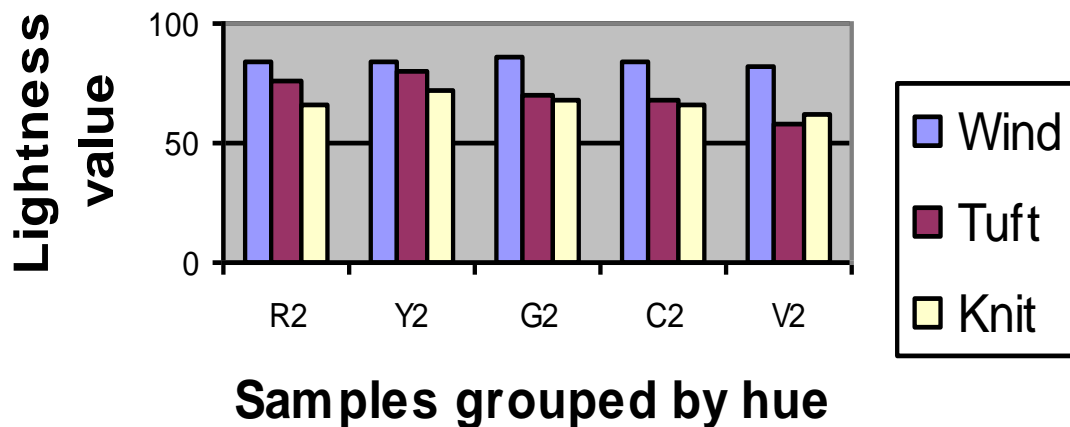


Results for samples  
with intrinsically  
low lightness  
and low chroma



MDD<sub>c</sub>  
is negative  
for tufts

## Variation of Lightness with Texture

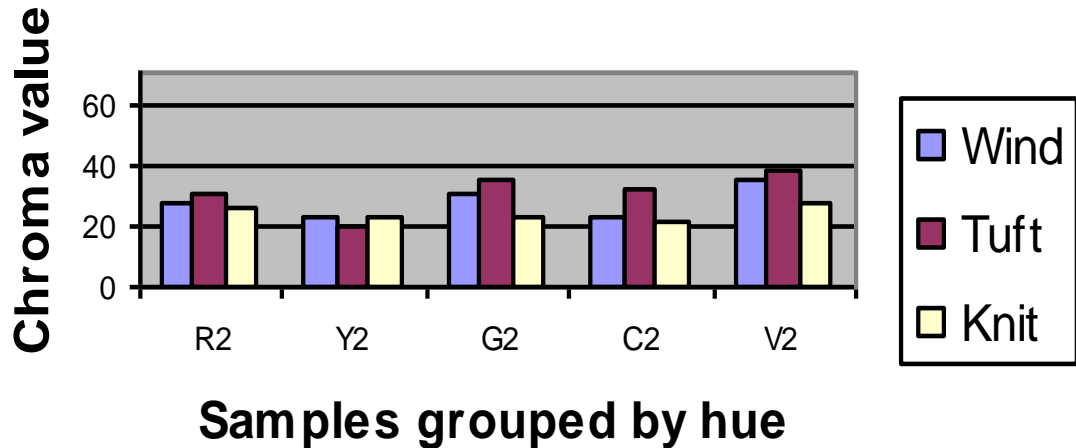


Results for samples  
with intrinsically  
high lightness  
and low chroma

MDD<sub>c</sub>

is now positive  
for tufts

## Variation of Chroma with Texture





Results for samples

with intrinsically

low lightness

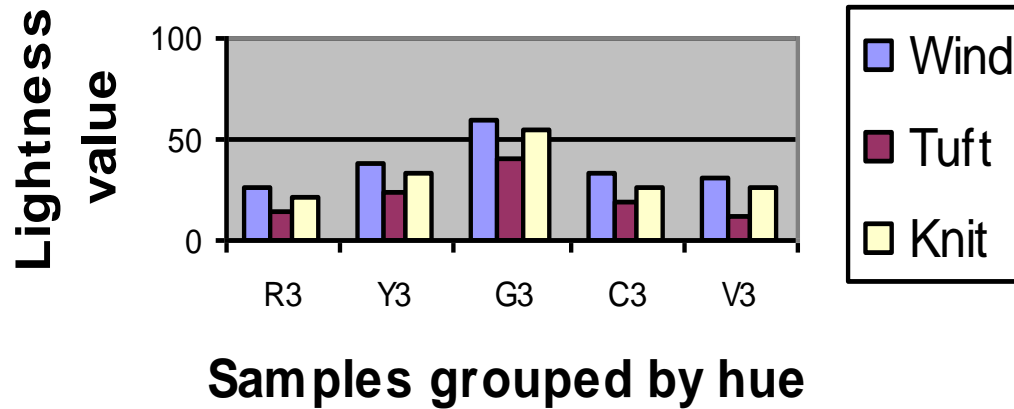
and high chroma

MDD<sub>c</sub>

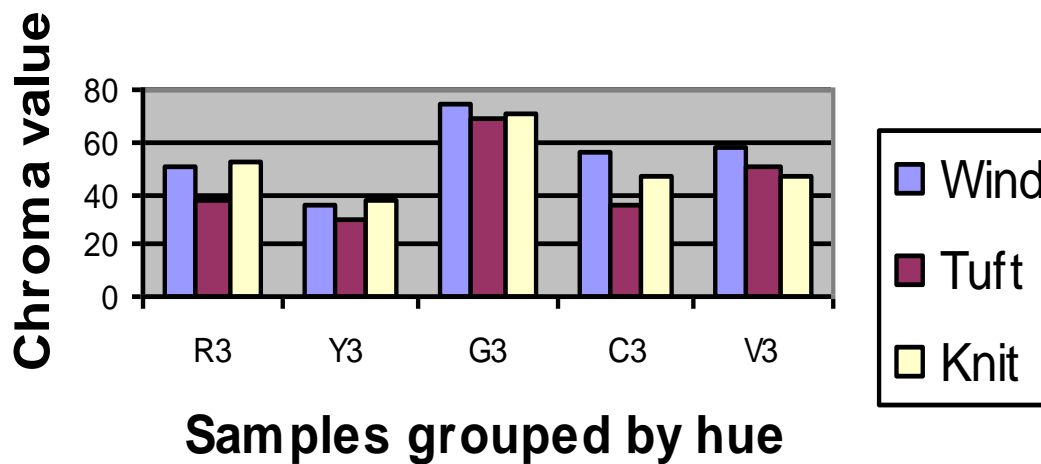
is again negative

for tufts

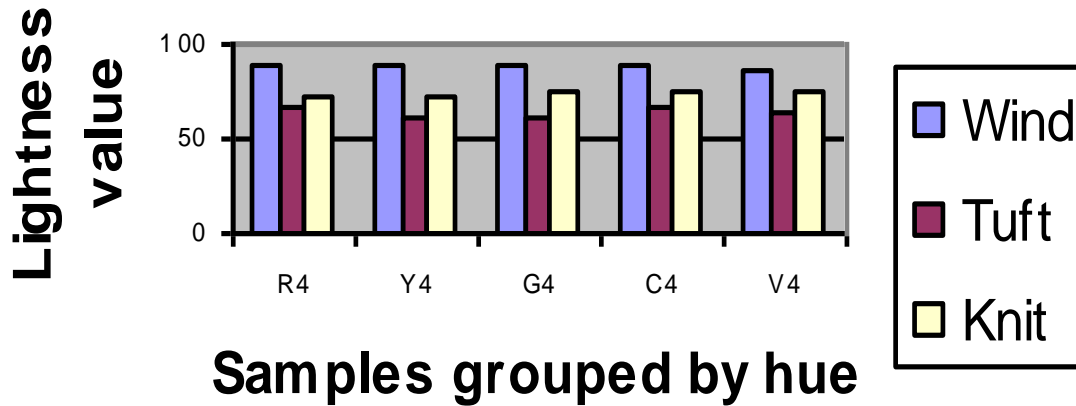
Variation of Lightness with Texture



Variation of Chroma with Texture

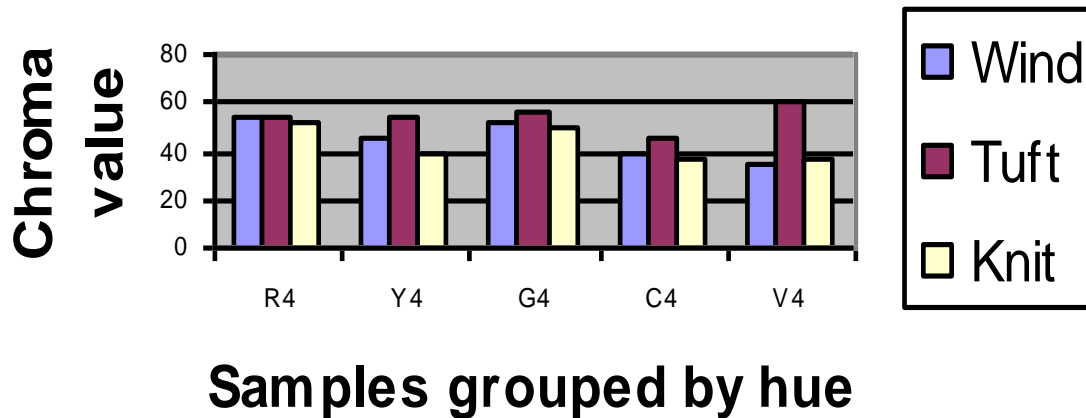


## Variation of Lightness with Texture



Results for samples  
with intrinsically  
high lightness  
and high chroma

## Variation of Chroma with Texture



MDD<sub>c</sub>  
now has increased  
positive value  
for tufts  
compared to low  
lightness samples



# Individual variations with lightness and chroma

**MDD Trends from reference texture  
for individual lightness and chroma groups.**

## **TEXTURE      MDD values for samples with Low Chroma**

	Low lightness			High Lightness		
	$MDD_L$	$MDD_C$	$MDD_h$	$MDD_L$	$MDD_C$	$MDD_h$
<b>Tufts</b>	-17.25	-5.00	1.12	-13.83	3.32	2.20
<b>Knits</b>	-10.43	-3.20	-2.32	-17.43	-3.82	-0.64

## **MDD values for samples with High Chroma**

	Low lightness			High Lightness		
	$MDD_L$	$MDD_C$	$MDD_h$	$MDD_L$	$MDD_C$	$MDD_h$
<b>Tufts</b>	-15.12	-10.35	1.34	-24.89	9.18	1.96
<b>Knits</b>	-5.56	-3.86	-1.94	-13.85	-2.38	-3.84

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# Conclusions

**MCI** (*Mean Colour Identity*), **MDD** (*Mean Directional Deviation*), **MVD** (*Mean Vector Deviation or Displacement*), and **Intrinsic Colour**, are introduced as measures of colour appearance change with varying texture.

They are shown to relate texture and colour in analyzable ways.

A tentative start has been made on image based colour analysis

The role of texture in colour appearance may prove to be measurable.

