Black-and-White High Resolution Photography – A Guideline

by Heribert Schain

1. Whatever is High Resolution Photography?

Best imaging quality and resolution are usually achieved by resorting to large or very large shooting formats, and in digital photography respectively, by the use of large and expensive memory chips. What is crucial to these methods is the high resolution of the print being realized by a relatively small magnification, with the result that high resolution is only attained on the print but not on the large-format negative or memory chip. Thus the storage media used in this regard for the first storage of the photographic image do not possess high resolution. The stored images are consequently not very suitable for enlarging and so can only attain high resolution by their sheer size, which naturally generates serious disadvantages and leads to higher cost on account of the size of the necessary equipment.

High resolution photography on the other hand accomplishes best imaging quality and high resolution using a small shooting format (ordinarily 24x36mm or Minox 8x11 format), which due to the use of high resolution film material and outstanding optical systems boasts an uncommon enlargement capability. Here high resolution is already realized on the first storage medium (i.e. high resolution film) and then transferred to a print through a much higher magnification ratio. *High resolution photography only exists on film, i.e. in the analog field.*

2. Why High Resolution Photography?

Black-and-white film material, normally used for documentation and microfilming, has been subject to numerous more or less successful attempts at tapping it for pictorial photography during the last few decades. One of the reasons for this has been the wish to realize high quality and greatly enlargeable negatives with smaller formats as well, above all with the aid of 35 mm photography. This is the only way to use the advantages of small-format photography for photos with great imaging quality. Thanks to the low weight of the required equipment and apart from that, the easy availability of extreme focal lengths, small format in contrast to larger formats enables so-called *dynamic photography.*

A ubiquitous example of this is the Kodak Technical Pan film. Unfortunately the latter is not available as stock any more. It disposed of a resolving power of 100 lp/mm at a contrast ratio of 1.6:1, and a resolving power of 320 lp/mm at a contrast ratio of 1000:1. Besides it stood out by overwhelmingly fine grain in pictorial development at Beta 0.6 (RMS 5, measured at a micro-densitometer measurement aperture of 48µ in diameter, at a 12x magnification and density 1 of the sample).

3. State of the Art before Modern High Resolution Photography Was Introduced

Today's best modern T-crystal films (ISO 100/21°) resolve 200 lp/mm at high contrast and ca. 60 lp/mm at low contrast and possess a granularity of about RMS 7 to RMS 8, measured in identical conditions. Up to now this lead of the Technical Pan over the best modern black-and-white films could not be challenged.

Even so, conventional films have been much more suitable for most shots than high resolution microfilms. *This was above all due to there not being any flawless developing techniques for pictorial purposes, not even for the Technical Pan, which back then was the only microfilm that had available sufficient speed in this area.*

The other well known microfilms as e.g. Afga Copex Rapid and Kodak Imagelink HQ simply could not be used in pictorial photography because of their lack of exploitable speed when processed with conventional developing techniques.

The use of microfilms in pictorial photography used to be subject to the following disadvantages:

- low film speed
- bad rendering of tonal values
- insufficient exposure latitude
- smudging of halation at high contrast range
- flawed development (turbulence clouds and other artefacts)
- lack of reproducibility
- incompatibility with wetting agent residue
- lack of sharpness by reason of insufficient detail contrast with low subject contrast and/ or small enlargement scale
- low density range in the way of rich blacks and pure whites
- poor shelf life, etc.

Most of these problems have so far been considered as due to emulsion, and therefore as impossible to compensate by development.

As the previous developing techniques for microfilms could not solve these problems, it was impossible to obtain reproducible results of constant quality in the use of high resolution stock. Although in individual cases it was well possible to achieve excellent results, many users were disappointed and turned away from high resolution photography.

4. Today's Black-and-White Film Materials for High Resolution Photography

Contemporary high resolution films boast a higher resolution than even the best taking lenses. This did not yet apply to Kodak Technical Pan with its maximum of 320 lp/mm. The films in question are so-called document copy films or microfilms, which are actually produced for the purpose of microfilming. As a consequence of their monodisperse distribution of grain, they are equipped with very high resolution. However by the same token they are not suitable for pictorial photography if normal developers are used because apart from the above stated problems, they cannot render differentiated grey scale values. It is due to their steep gradation, which is in the way of the purpose of pictorial photography, that they can only reproduce black and white. These films can hence only be used in conjunction with a special developing technique enabling their flawless usage in pictorial photography.

5. SPUR High Resolution Developing Techniques – Historical Review

In 2001, after many years of research, SPUR Photochemie presented its novel developing technique for Kodak Technical Pan, SPUR Dokuspeed Professional, which completely eliminated the previous problems and difficulties in the development of that microfilm and allowed for an impeccable pictorial development at ISO 50/18°.

In 2002 and 2003 followed new developing techniques for the extreme high resolution films Agfa Copex Rapid (600 lp/mm at a contrast ratio of 1:1000) and Kodak Imagelink HQ (800 lp/mm at a contrast ratio of 1:1000). Employing these developing techniques (SPUR Nanospeed Professional for Agfa Copex Rapid, SPUR Imagespeed Professional for Kodak Imagelink HQ), the films in question could be processed without any problems and their resolution reserves could be fully used.

In this context you might want to consult, amongst other publications, *Photo Technik International*, ed. 2/2003 (March/ April), pp. 36–39, *Fine Art Photo*, ed. 1/2005, pp. 50–54, *Fine Art Photo*, ed. 3/2005, pp. 26–30 and *Fine Art Photo*, ed. 3/2006, pp. 42–44. Please note that those articles are written in the German language. There is an English article in *Black & White Photography*, October 2005, pp. 68–71.

In 2006 the developing technique SPUR Orthopan UR + SPUR Nanospeed UR, a film/ developer combination, was launched on the market, boasting the highest resolution available worldwide at the time.

By means of this developing technique, the theoretical limit of diffraction was visualized for the first time on a microfilm developed for pictorial use. This was accomplished by Carl Zeiss in Oberkochen, Germany.

On February 24, 2006, *Zeiss Camera Lens News* wrote: “The high resolution film of choice was the SPUR Orthopan UR supplied and processed by SPUR. The result was a whopping 400 lp/mm on film, recorded with the Biogon 25 at f/4 in the center of the image. This value, 400 lp/mm, corresponds to the maximum resolution theoretically possible at f/4; in other words it represents the calculated “diffraction limited” performance at this aperture. It is noteworthy that this test was conducted with a production lens on a production camera, indicating that the film was precisely positioned and flat.”

Further information on this developing technique could be found under the heading *Der schärfste Film der Welt (The Sharpest Film in the World)* in *Photo International*, ed. 5/2006, p. 70–71. Please note that this article is written in German.

In 2010 roll films and even a 4x5” sheet film were added to the ADOX microfilm range (ADOX CMS 20). Previously only 35 mm had been available. By these circumstances a new developing technique turned out to be necessary, for the already difficult development dynamics of high resolution films depend on the format, becoming more difficult with large formats. So the hitherto existing SPUR developing techniques for microfilms were replaced by the SPUR Modular UR developing technique, which was made up as a developing kit and permitted the trouble-free development of DSX/ Agfa Copex Rapid and SPUR Orthopan UR roll films as well. Certainly the shelf life of SPUR Modular UR was only 12–15 months, the working solution lasted merely 1–2 days.

6. 2015: Current High Resolution Developing Techniques by SPUR

A. SPUR DSX/ Agfa Copex Rapid + SPUR Dokuspeed SL

SPUR Dokuspeed SL is a new special developer for the pictorial development of the high resolution SPUR DSX/ Agfa Copex Rapid film, and so replaces the previous SPUR Modular UR developing technique for this microfilm.

SPUR Dokupeed SL enables much easier, straightforward handling and development, making high resolving power photography quickly accessible for first time users. The up to now rather exacting, dynamic developing process is no longer applicable because SPUR Dokuspeed SL is very easy to use and exhibits a very high fault tolerance.

SPUR Dokuspeed SL improves the previous standard in every respect. This new developing technique attains a much higher detail contrast, which leads to unprecedented sharpness and shadow differentiation equalled neither by rivalling analog techniques nor digital photography. By virtue of the high exposure latitude even very high contrasts are mastered and tones are rendered which other developing techniques cannot provide.

The key advantage however is the very long storage life of the new developer of 3 to 4 years. Even after more than 4 years, the same developing results are achieved with no loss in either contrast or speed. In contrast to previous developing techniques the working solution is also extremely stable (4-6 weeks in a full bottle).

SPUR Dokuspeed SL can moreover be manufactured in a much more cost-efficient way than previous Modular developers. This saving of costs is benefiting the user, for the price per film development is now considerably reduced.

SPUR DSX disposes of a resolution of 600 lp/mm at a contrast ratio of 1000:1. The graininess as a RMS value is 9. These figures were taken from the Agfa data sheet and are applicable for the development with conventional microfilm chemicals. If developing for pictorial use at normal contrast with SPUR Dokuspeed SL, there is less grain and RMS is ca. 7-8. These are estimated figures. Exposure latitude is exceedingly high, amounting to 12-14 f/stops at normal pictorial contrast.

Therefore this combination is especially suitable for problem-free shooting with respect to various subject contrasts, which are easily mastered by the exposure latitude. In conjunction with the new developer SPUR Dokuspeed SL you may choose all speeds between ISO 25/15° and ISO 50/18°. Regardless of subject contrast, every developed negative can be printed smoothly with tonal values as desired. Sharpness, detail contrast and resolution are substantially improved in comparison with Kodak Technical Pan, while grain is slightly more visible.

B. SPUR Orthopan UR + SPUR Nanospeed SL

SPUR Nanospeed SL 135 is a new special developer for the pictorial development of the maximum resolution SPUR Orthopan UR 35 mm film, and so replaces the previous SPUR Modular UR developing technique for this microfilm. This developing technique is offered as *Nanospeed SL 135* for the pictorial development of SPUR Orthopan UR 35 mm film and as *Nanospeed SL 120* for the pictorial development of SPUR Orthopan UR roll film. ADOX CMS 20 films can also be developed with SPUR Nanospeed SL 120 without any difficulty.

SPUR Nanospeed SL 135 enables much easier, straightforward handling and development, making high resolution photography quickly accessible for first time users. The up to now rather exacting, dynamic developing process is no longer applicable because SPUR Nanospeed SL 135 is very easy to use and exhibits a very high fault tolerance.

SPUR Nanospeed SL 135 improves the previous standard in every respect. This new developing technique attains a much higher detail contrast, which leads to unprecedented sharpness and shadow differentiation equalled neither by rivalling analog techniques nor digital photography. Owing to the high exposure latitude even very high contrasts are mastered and tones are rendered which other developing techniques cannot provide.

The key advantage however is the very long storage life of the new developer of 3 to 4 years. Even after more than 4 years, the same developing results are achieved with no loss in either contrast or speed. Plus, in contrast to previous developing techniques the working solution is extremely stable (4-6 weeks in a full bottle).

SPUR Nanospeed SL 135 can moreover be manufactured in a much more cost-efficient way than previous Modular developers. This saving of costs is benefiting the user, for the price per film development is now considerably reduced by ca. 50%.

SPUR Orthopan UR is an orthopanchromatic microfilm. It can be developed for pictorial use without any problems employing SPUR Nanospeed SL, a developer that is ideally suited to this film. Speed amounts to ISO 6/9° - ISO 12/12° depending on the contrast chosen at development. If the subject contrast is low and you go without shadow details, ISO can be set to 20/14°.

The theoretical resolution comes to 800 lp/mm at a contrast of 1000:1. Granularity is more fine than with all other above mentioned microfilms; nevertheless by reason of the development-specific, high detail contrast a high degree of sharpness is attained. Exposure latitude is very high (more than 10 f/stops) and enables easy shooting even with high subject contrasts.

7. High Resolution in Practice

What does this mean for the photographic practice? It is a popular misconception to think that the high resolution attainable by now does not play a role in normal practice because it cannot be used. When are the conditions such that such technical boundaries are reached in everyday photography, you may ask.

This however is the wrong approach to tackle this question. In simple terms, there is the following difference between a normal microfilm and high resolving power material like SPUR Orthopan UR: a high-class objective lens as e.g. the Zeiss Biogon T* 2,8/25 ZM, which was used for the Zeiss high resolution record, disposes of about twice the resolution of a normal black-and-white film (of the best quality). By contrast, SPUR Orthopan UR possesses about twice the resolution reserve of such a sophisticated lens.

If the theoretical resolution values at a high contrast of 1000:1 were the only issue, the use of high resolving power microfilms in pictorial photography would not make any sense anyway. As due to the physical limitation by diffraction even the best lenses cannot make full use of the resolution of these films, at a high contrast of 1000:1 you may at best be able to dissolve 400 lp/mm instead of the 200 lp/mm which can currently be achieved with the best black-and-white films. Further, in this perspective the results of contemporary high resolving power films would have to be considered nearly identical to what could be attained by Kodak Technical Pan, which at a high contrast of 1000:1 was able to dissolve 320 lp/mm after all.

This approach for its incompleteness cannot explain the huge quality advantage of high resolution microfilms over conventional black-and-white films.

Now in pictorial photography you are usually not particularly dealing with high contrasts, but with medium to low contrasts. At these contrasts of ca. 64:1 down to 1.6:1 and with low detail contrast, a customary film displays such a low resolution that it is unable by far to render the lens performance. As a consequence, an enormous quality difference becomes visible especially in the field of low and medium contrasts. This reveals the yet inactive performance reserves lying dormant within the objective lens.

In terms of numbers: at a subject contrast of 1.6:1 the best conventional black-and-white films resolve no more than 60 lp/mm, whereupon the detail contrast in this range is exceedingly low and sharpness subsequently poor. Photographers have become so accustomed to this quality that they consider it normal.

However at the same contrast of 1.6:1, SPUR Orthopan UR in conjunction with SPUR Nanospeed SL resolves tremendous 250 lp/mm. This is more than what even the best conventional black-and-white films can resolve at a high contrast of 1000:1. Moreover detail contrast and hence sharpness are tremedously high. That is why greatly enlarged images from high resolving power negatives may cause attention and surprise in the beholder not yet familiar with this technique.

Some users who have never tried modern high resolution photography for themselves also mistakenly do not believe it to be suitable for studio and landscape, but solely for architectural photography due to tonality.

This view represents a state of knowledge of 20 years ago and refers to the inadequate developing techniques for microfilms at the time, as e.g. the former Gigabit developing technique. In contrast to this assumption, modern high resolution photography boasts better tonal values and a higher exposure latitude than customary black-and-white films. Employing the new SPUR Dokuspeed SL and SPUR Nanospeed SL developing techniques, contrast can be perfectly adjusted to the subject contrast during development.

Even solely in view of their orthopanchromatic sensitization, high resolution microfilms are more eligible for landscape photography than customary black-and-white films. Red and green shades are neatly rendered as various grey tones without a filter and vegetation is rendered in a much more sophisticated way than with customary black-and-white films. The rendition with this kind of sensitization, which supersedes the use of a yellow filter, could be described as a correct depiction of all tone values.

Hence the only restriction left is the relatively low speed of high resolving power film material. But even here, using the new SPUR developing techniques, you can work with SPUR DSX/ Agfa Copex Rapid at ISO 50/18° without any problems.

8. High Resolution and Digital Technology (Analog-Digital Interface)

If, in addition to analogous processing (photochemical enlargement in a conventional lab), you wish to use the digital option, exploring the possibilities of modern computer technology, you should prefer to use a high resolution film whenever low speed allows it. On account of the much lower thickness of emulsion and the monodisperse distribution of grain, high resolving power films can be scanned far more easily than conventional black-and-white films, whose grain will scatter as a consequence of the considerably thicker emulsion and the different grain distribution. The latter can therefore be scanned only with an outcome of diminished quality.

High resolution films on the other side lend themselves to scanning, for as with colour films, there will be no loss in quality. As they naturally dispose of a much higher resolving power than normal black-and-white or colour films or especially, digital photography, you can thus, yet depending on the resolution of your scanner, create picture files of an overwhelmingly high quality, which after processing will enable you to produce prints of a quality previously unknown in relation to the shooting format.

The prints thus created do not however arrive at the quality of photochemically created prints, for the resolution of even the best high-performance scanners is by far not sufficient to make full use of the resolution reserve of high resolving power films. Scan quality is therefore much higher if not the negative itself but a photochemically created DIN A4 print is being scanned using a flat bed scanner; though with this method, you need to interpose another lens.

9. Cameras and Optical Systems for High Resolution Photography

Only the best, premium cameras and lenses as e.g. the Zeiss camera systems are fit for high resolution photography. Since high resolution films, as expounded above, dispose of a substantially higher resolution reserve than even the most high-grade taking lenses, the differences become completely obvious here. The use of adapted camera systems checked for focus differences by focus bracketing is vital in this regard. With SLR systems you have to pay attention to the correct adjustment of mirror. Only premium lenses with additional high luminance should be used.

10. Photo Technique

Do take care to avoid camera shake when shooting. This is universally applicable, but especially important in high resolving power photography because here even the slightest of camera shakes noticeably minimizes resolution. As e.g. the ultra high resolving SPUR Orthopan UR has available relatively low speed, with this film it is strongly advisable to use a tripod. In bright light the camera may be hand-held when choosing a short shutter speed with relatively large apertures.

You should only use the medium aperture speed ranges of ca. 2.8/4 to 8 (this is valid for 35 mm; for greater formats you can choose smaller apertures). In theory, with greater apertures you admittedly obtain a higher resolution, which is however negatively overcompensated in this field by higher order aberrations (e.g. spherical aberrations). Apertures smaller than 8 f/stops conspicuously minimize the attainable resolution due to diffraction. If for reasons of artistic image composition a higher depth of field is necessary, you will indeed have to stop down at least one stop more than usual, since in high resolution photography demands on the diameter of the circle of confusion are different. While the attainable resolution is certainly substantially lower when using small apertures, it is still significantly higher than with customary film material.

11. Development

Please refer to the SPUR data sheets when developing.

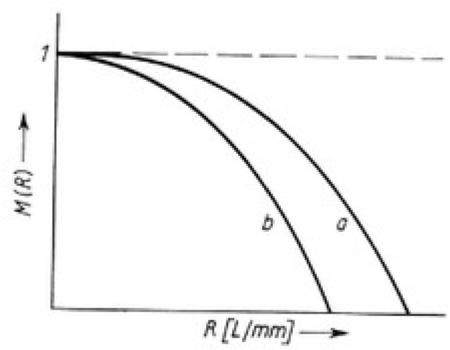
Appendix

1. Resolution

We define the resolution of a photographic system as its capability of clearly rendering or resolving a certain number of line pairs at a certain contrast ratio (subject contrast).

A proven method of measuring the resolution of such a system is the so-called modulation transfer function (MTF). *The MTF measures the resulting contrast or loss of contrast of the system depending on the resolution.* Thus the resolution is measured in line pairs per mm (lp/mm). The higher the resolution (high local frequencies), the lower the contrast, which at some point drops to zero. Inversely, maximum contrast correlates to minimum resolution (local frequency).

The following drawing may serve as an illustration outlining the MTF of two different photographic materials:



Krug, Wolfgang & Weide, Hans-Günter (1976) *Wissenschaftliche Photographie in der Anwendung*, 2nd edition, Leipzig: Akademische Verlagsgesellschaft Geest & Portig K.-G.

a = higher resolution material

b = lower resolution material

2. Exploitable Resolution

When comparing microfilms with conventional black-and-white films, you must at all times consider the difference between potential and exploitable resolution. *Exploitable resolution is the higher, the lower the scale ratio at shooting and the higher the enlargement scale of the print.*

In general, the differences in the resolution of two materials can be perceived all the better, the higher the reduction at shooting and the higher the enlargement of the print. Conversely, the appearance of sharpness at a high aspect ratio and a relatively low enlargement scale cannot predict the resolving power of a certain material or technique. If on the other hand a low aspect ratio is combined with a great enlargement scale, a high resolving power film (in conjunction with the right developing technique) cannot be rivalled.

The chosen enlargement scale in conjunction with the resolving power of the photographic paper is an all-important factor in the comparison of photographic enlargements with respect to the resolving power of the shooting material. A difference in resolution can only be perceived by the human eye if the enlargement scale is so great, that the resolving power of the photographic paper is higher than the resolving power of the image detail rendered on the baseboard (the more resolving the film, the higher the thus necessary *limiting scale of enlargement*. If however the enlargement scale is lower, it may well be that a lesser resolved negative sounds sharper as a print, since the appearance of sharpness does not result from resolution alone, but apart from that from detail contrast and contour sharpness, both of which are down to reasons emulsion technological as well as development kinetic.

3. Sharpness

The concept of *sharpness* plays a decisive role within the scope of image quality. Sharpness essentially is a subjective visual impression, which in detail is quite indeed made up of measurable parameters, but cannot overall be measured as the sum of these parameters. Even a division in single, measurable factors only leads to fractal decomposition, whose weighting cannot be determined and therefore is not conducive to evaluation. Sharpness is an extremely complex concept that cannot be consistently defined or measured (the whole is more than the sum of its parts).

Still some essential parameters of sharpness must be defined as such by means of a qualitative evaluation so as to be able to arrive at a conclusion that allows for a sensible evidence of image quality.

Resolution alone in this respect is no criterion of sharpness. It merely indicates how many line pairs per mm can still be perceived or resolved respectively by the film. Even enlargements of high speed and therefore, low resolution films can, e.g. at low enlargement scales, feature high image sharpness, as every amateur photographer will know. High resolution alone merely creates the possibility of realizing high image quality even with very high magnifications, when the other conditions warrant it.

For the main part, image contrast is key to a great impression of sharpness. There is a relation between resolution and contrast, which is expressed in the above stated modulation transfer function. *The latter describes contrast as subject to resolution* (see above). As the large-scale contrast is given by gradation and (depending on the subject contrast) can be varied through development only within certain limits, for otherwise there will be no photographic rendering with a reasonably rich tonal range, the key success factor here is detail contrast. In this instance, it is especially important in which spatial frequencies there is still high detail contrast. If in very high spatial frequencies the detail contrast is still high, the image will appear very sharp.

Hence follows that only high detail contrast combined with high resolution will entail high image sharpness. Yet what is important in this context is the so-called *contour sharpness.* This is a measure of the blurring effect that comes about at an exposed sharp edge due to halation, i.e. the light scattering in the layer. A high blurring effect (= low contour sharpness) decisively diminishes detail contrast and so contributes to a poor impression of sharpness.

Contour sharpness must not be confounded with so-called edge effects as the vicinity effect or the Eberhard effect. The latter are development effects, which may increase sharpness, but take place in spatial frequency ranges not yet included in high resolution (in the range of ca. 60–80 lp/mm). These are therefore *not* to aimed at in high resolution photography!

It is only via maximization or minimization of halation by development kinetics that contour sharpness can be influenced by development. So essential requirements for image sharpness are *high contour sharpness and thus a high detail contrast in high spatial frequencies.*

4. Problems with Monodisperse Grain Size Distribution in Microfilms

The main differences between a high resolution microfilm and a normal black-and-white film are caused by a fundamentally different Gauss grain size distribution in conjunction with a substantially lower layer thickness. Consequently high resolving power microfilms dispose of a monodisperse grain size distribution, i.e. the layer consists of silver crystals of the same size, which apart from that are much smaller than the ones in customary black-and-white films. Besides, the layer thickness (ca. 5µ or less) is considerably lower than in ordinary black-and-white films. These emulsions for their part are composed of differently sized grains, with size differences being all the more obvious the more sensitive the material. The layer thickness of these materials is significantly higher and usually amounts to ca. 8–15µ.

The different grain size distribution does not merely induce the considerably higher resolution of high resolution microfilms, but the latter also causes other differences against normal materials, which are not generally known and therefore are looked at in more detail below.

For a start, special gradation diffracting developing techniques must be used on account of the monodisperse grain size because the use of customary film developers does not bring about a pictorial, but a significantly steeper gradation over Beta 1.0. The attempt of achieving a pictorial gradation by strong underdevelopment with normal film developers leads to a far too low exploitable film speed and turbulence clouds, which specifically occur in cohesive large grey areas.

The other crucial differences against normal black-and-white materials mainly ensue just from the necessary gradation diffracting development in conjunction with the monodisperse grain size distribution.

In this context *grain size* is absolutely crucial for detail contrast and contour sharpness. In the case of monodisperse grain size distribution, grain size is an important factor for achieving high resolution. If your aim is resolution alone, the latter can be further increased by decreasing grain size on emulsification. However this approach affects both the attainable speed and image sharpness.

Reducing grain size results in light scattering in the layer, thereby diminishing contour sharpness and detail contrast. If the grains are too large, small details cannot be dissolved any more, a phenomenon exclusively down to grain size. This directly diminishes the resolution attainable.

Hence follows that depending on the attainable speed there is an optimum grain size, which on the one hand allows for as high as possible an immediate resolution and on the other hand, by minimizing halation as much as possible, ensures as high as possible detail contrast and contour sharpness.

As microfilms are however not produced for pictorial use but for microfilming, and thus are conceived for a development with considerably steeper gradation (higher large area contrast), the optimization of grain size in the production does not ensue with regard to the requirements of pictorial photography, but with regard to microfilming.

Because of the increase in detail contrast and contour sharpness caused by the steeper gradation, grain size with respect to the attainable resolution can be kept substantially smaller than would be required for pictorial use.

Apart from that, detail contrast in the context of the modulation transfer function declines the more, the higher the values taken on by the spatial frequencies. So a pictorially developed microfilm, by reason of the grain size not being optimized for pictorial use, has got a higher light scattering in the layer, and especially in the higher spatial frequency areas (less contour sharpness), and therefore a considerably lower detail contrast than ordinarily developed microfilms.

Using non-optimized developers in connection with low subject contrast, this may lead to a poor impression of sharpness in spite of the high resolution. It is only with high or very high enlargement scales respectively that you do notice the resolution being comparatively better than with normal black-and-white material. Using non-optimized developers however, the higher light scattering in the layer combined with the monodisperse grain distribution and high subject contrasts in the highlights leads to a smudging or concretion of halation and therefore, a too low exposure latitude effecting a low resolution in the highlights, which does not nearly measure up to the potential of high resolving power material.

5. Requirements for an Optimized Developing Technique Resolving the Problem

A. The developer must be able to bring about relatively high speed in combination with a pictorial gradation.

B. The developer must compensate the reduction of density range caused by gradation diffraction.

C. With regard to development kinetics, the developer must be designed in a way so as to prevent the formation of turbulence clouds in larger cohesive grey areas or grey gradients.

D. In view of development kinetics, the developer must minimize halation and maximize detail contrast in such a manner that even with high subject contrasts in the highlights there is no smudging of halation and even with low subject contrasts there is still a good degree of sharpness, in order that on the whole the result is a high exposure latitude and the resolution specific to the material is preserved.

E. Concerning development kinetics, the developer must influence granularity in a fashion that on the one side the grain is fine still, while on the other side neither detail contrast nor contour sharpness are affected by that fineness of grain.

We have been researching the optimization of SPUR high resolution developers as described in the five above mentioned points since the mid-1980s and have solved all problems in this field, the result being our SPUR Dokuspeed SL and Nanospeed SL developers.

Translated into English from the original German by Anita Schain